PLUG COMPATIBLE

CRT DISPLAY TERMINALS

INPUT

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PLUG COMPATIBLE CRT DISPLAY TERMINALS

Prepared For:

OKI ELECTRIC INDUSTRY COMPANY, LTD.

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PLUG COMPATIBLE CRT DISPLAY TERMINALS

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1 INTRODUCTION

I INTRODUCTION

A. PURPOSE AND SCOPE

- This custom report entitled, "IBM Plug Compatible CRT Display Terminals," is prepared solely for the Oki Electric Industry Company, Ltd.

- The purpose of the report is to determine the likely design concepts and product or functional specifications for future IBM CRT display terminals. The scope of the information provided will be such that the Oki Electric Industry Company, Ltd., may be prepared to offer comparable products to the Japanese marketplace in the immediate future.

- In conjunction with analyzing IBM's design concepts and functional specifications, as available, market research analysis will be directed to the overall competitive environment which fosters the demand for IBM plug compatible display terminals and controllers. In concert, accompanying IBM market/product strategies associated with current and future network plans will be addressed as these plans pertain to the U.S. marketplace.

- INPUT conducted a comprehensive survey interview of the IBM CRT terminal market encompassing major PCM vendors and major users. The scope of the surveys addressed the following key study issues for both vendors and users. Interviews were tailored to the interpretations, actions and plans of the separate segments.

- IBM's anticipated H/F/S strategies.

- The impact of technology changes on products, markets and applications.

- Factors which influence the users selection decisions.

- Projections and evaluations of IBM's future direction relative to SNA and supported protocols.

- Possible announcements of other IBM terminal products and their impact on IBM's market share as well as that of each PCM vendor.

B. RESEARCH AND METHODOLOGY

- The research and subsequent findings for this custom study was derived from two sets of questionnaires developed by INPUT and utilized both telephone and on-site interviews, conducted by senior research personnel. Leading U.S. PCM vendors were surveyed along with key members of the user community. Interviewed personnel represented managerial decision makers in both questionnaire segments. In addition, private discussions were conducted with computer media information analysts and research engineering personnel engaged in evaluating 327X units.

II EXECUTIVE SUMMARY

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A. MAJOR CONCLUSIONS

- The 327X Information Display System (IDS) will be continued by IBM as its primary display system series for the next several years.

- The design philosopy of the 327X series in terms of its reliance on SNA architecture, SDLC protocols, and emphasis on software resident in the host computer will not change.

- IBM's policies towards pricing, sales terms and conditions, marketing emphasis, etc. will be designed to ensure IBM a minimum 60% market share of the display terminal business.

- Within the 40% "opportunity window" left for others, significant opportunities exist for the PC vendor.

- Today, and for the next three years at least, IBM's emphasis will be on the 3278 display, 3276 display/mini-controller, and 3274 controller. All of these units interface to IBM computers via channels, and, to the extent the channel interface specifications are understood, these systems are subject to PC vendor displacement.

- Except in specific circumstances, IBM display systems will continue to be functionally oriented rather than tailored to specific applications.

  - Exceptions include such specialty devices as airline reservations terminals and special purpose military display systems.

  - The 3278 has an extra key which can be adapted to a special function.

  - 3278 keyboards can be tailored and fitted with overlays.

- All future enhancements of the 3278 series will be provided to increase the IDS' functional capability.

- IBM has structued the 3274/76/78 pricing so that the system price remains high while the cost of individual CRT displays is low. This strategy makes it appear to the user as an overall price reduction and tends to lock-in the user to IBM once he has purchased a controller unit.

- The 3278 display is offered in four models ranging from 960 to 3440 characters - generated by dot matrices ranging from 7 x 9 to 7 x 14.

  - The standard character set contains matrices for most languages of countries served by IBM.

  - Katakana is offered as an option.

  - Kanji is not supported. INPUT believes IBM has no plans to support Kanji.

- The announcement of the 3278 had a dramatic effect on the market. Backlogs were so huge, IBM was not able to offer delivery for 18 months at time of announcement (1977).

- 1979 orders (in the U.S.) are still backlogged 6-9 months.

- IBM recently increased U.S. manufacturing capacity to 225,000 units per year.

- Long IBM delivery cycles have accounted for much of the PC display system business in the last three years.

- The inroads made in the 3278 base by PC vendors has been countered by IBM by:

  - Reducing lease prices and offering two year leases with purchase credits on the 3278 for 3277's.

  - Adding enhancements to the 3278's.

  - Reducing the cost of the 3278 by going to high volume production custom LSI.

  - Moving all intelligence into the 3274/6 controllers, purposely making it difficult for a competitor to analyze and duplicate.

- IBM's new documentation policies make it difficult for PC vendors to obtain interface specifications.

  - Use of custom LSI in controllers will delay PC entries and suggest that IBM can offer enhancements easily that PC vendors will not be able to respond to quickly.

  - The 3274 disc and microprogram capabilities suggest that IBM will add (as needed to stay ahead of PC vendors) features and/or programmability in the future.

- IBM offers the 8775 with the 8100 and the 5250 with the System/38 although the 327X could serve all IBM systems equally well.

- Part of the reason for this proliferation of display systems has to do with competition internal to IBM.

- This variety of terminals has, in effect, taken one large market, broken it into three parts and created three separate markets, each of which is greater potentially than any one earlier market.

- The three independent developments will permit IBM to shift emphasis from product line to product line in the event that market share erosion in any one area becomes greater than IBM wishes.

- INPUT believes that the product life cycle for the 3274/6/8 line will be six years. A new system is not expected before 1983.

- IBM is following a consistent H/F/S strategy.

  - Software is the province of the host.

  - Firmware is established in the controllers.

  - Display devices are hardwired.

  - Thus, most significent feature upgrades will occur in the software at the host level - good news for PC vendors!

  - Keeping display terminals hardwired allows IBM to minimize manufacturing costs. INPUT estimates IBM's 3278 costs at $500 per unit maximum in volume production.

- New 3274 equipment uses advanced but not high state-of-the-art technology.

  - High density chips (400 gates) are packaged four to a carrier (2.5 cm square) with 26 carriers on a board.

- The presence of so much circuitry indicates the systems have a high degree of built-in redundancy or future enhancement capability.

- The redundancy feature makes sense. IBM wants to minimize service on display devices but still sell expensive maintenance contracts.

- IBM will stay with the 70° deflection tube which gives high resolution at low cost and offers superior stability over the 110° tube used by other vendors.

  - INPUT believes it will be at least three years before flat panel displays can be mass-produced at costs competitive to CRTs.

  - IBM will not change display technologies until it makes economic sense to do so.

- IBM has a major R&D effort underway to develop color monitors.

  - They will probably first offer a high cost graphic terminal to compete with RAMTEK.

  - It is possible some of the unused codes in the 'A' interface may permit adding a color monitor to the 327X line.

- IBM is now fully dedicated to SNA and SDLC.

  - Adoption of SDLC as a de facto standard by large users will virtually lockout AT&Ts proposed ACS and guarantee IBM's ultimate success in the communications market.

- IBM is also dedicated to the promotion of the DDP (Distributed Data Processing) concept.

  - Ultimately, DDP will engender a need for component interchangability including storage devices, RAM, controllers, peripherals, etc.

- DDP, SNA, SDLC, etc. will force all PC vendors to operate under IBM's network umbrella. This means that display terminal PC vendors will have to be followers, not innovators.

- Availability (in the sense of reliability plus service) will be the key to PC vendor success in the future.

  - IBM is expected to set new reliability standards.

  - INPUT has learned that IBM expects to cut its hardware field service force by 20% over the next five years even though sales expect to continue growth at 15% overall and 20-30% in display terminals.

- The growth of the 327X market will be maintained for at least 3-5 years.

  - Market growth will be limited by processor availability and storage device availability.

  - The announcement of the "H" Series (between 8/79 and 4/80) will spur growth in addition to IBM's backlog of 50,000 433X systems which will take five years to fill.

- All major IBM software packages support the 327X and, in fact, assume that the 327X will be the major user terminal.

B. RECOMMENDATIONS

- INPUT believes OKI should seriously consider entry into the PC market, providing:

  - Profitability goals can be met at prices 15-20% less than IBM's.

- A capital investment of up to $20 million can be justified.

- Effort should focus on the 327X series.

  - The 8100 and System/38 markets offer opportunities but none so large and universal as the 327X.

- Japanese penetration can be enhanced via support of a limited Kanji character set.

- The initial product should be a 3278 replacement device.

  - 3276 and 3274 replacement control devices can follow.

- To fully exploit the market, OKI should develop a competent 4300/"H" Series software capability, especially relating to applications using Kanji I/O characters which IBM will not support.

- Design emphasis should focus upon reliability.

  - Redundant circuitry should be explored.

  - User operated remote diagnostics should be offered.

  - The devices should be engineered for user repair via unit or board replacement.

- To compete in world markets, OKI must offer a variety of lease and purchase plans.

- Any PC system offered must be fully compatible with SNA standards and SDLC protocols.

- PC vendors should stay consistent with IBM's H/F/S strategies. There is no advantage to offering additional intelligence at the display terminal/controller unit when IBM software will supply the intelligence functions.

  - Sycor and Olivetti have phased out their intelligence units and moved to new cheaper systems consistent with IBM architecture.

- Choosing between custom LSI and microprocessor based circuitry is a matter of convenience and manufacturing costs. It makes no difference to the user. The trade off is flexibility versus economics.

- There are three types of PC vendors:

  - Those offering individual components, e.g., Displays work with IBM controllers; IBM displays work with the PC vendor controllers.

  - Those offering systems including displays and their own controllers interfacing to host processor channels.

  - Those offering 327X compatibility plus local programmable intelligence.

- Each approach has its own advantages. OKI's decision should be based on its perceived current and future market potential in Japan and/or other countries in which it wants to operate.

- The 4300 could be the deciding factor. This machine will support up to 16 3278 display terminals without a 3274/6 controller. If 4300 acceptance is heavy in Japan, this could influence the decision of which strategy to take.

III EVOLUTION OF IBM's TERMINAL PRODUCTS

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A. THE 3270 INFORMATION DISPLAY SYSTEM (IDS)

- The 3270 Information Display System (IDS) was introduced in the early 1970's as a replacement for the outdated 2260's which had been announced soon after the System/360. The 3270 was noticeable for its stylish display station, the 3277, and for the new small size of its control units, the 3271 and 3277.

- The 3270 is classed as an "editing" display system. Based on format control information received from the host computer, the system itself can check to see that data is entered only into allowable fields. When all the data on the screen is ready to be sent to the host computer, the operator depresses the ENTER key and the format specified part of the data on the screen is sent to the control unit and on to the host. This "edit" technique differed significantly from the 2260 design and provided the impetus to establish the high market demand for 3277 type devices as well as providing opportunities for other PCM manufacturers with compatible products.

- The original 3270 IDS network consisted of the following display, controller and printer units.

  - 3271 Remote controller.

  - 3272 Local controller.

- 3275 Standalone display station - remote only.

- 3277 Display station, with 3271/3272 attach.

- 3284 Matrix printer, with 3271/3272 attach.

- 3286 Matrix printer, with 3271/3272 attach.

- 3288 Line printer, with 3271/3272 attach.

- As shown in Exhibit III-1, it is the function of the controllers to act as a buffer between the attached display stations or printers and the channel or communications line, and to control the transfer of information to or from the buffer over the line or channel. The controller did not participate in the "editing" functions.

- Data is held in memory in each 3277 where it can be changed, added to or deleted by the operator. All "procesing" of the data is done in the 3277. This means that only certain keys cause any transfer of data to or from the control unit and the host CPU.

- The significance of the 3270 IDS network is:

  - IBM's recognition of the "editing" marketplace.

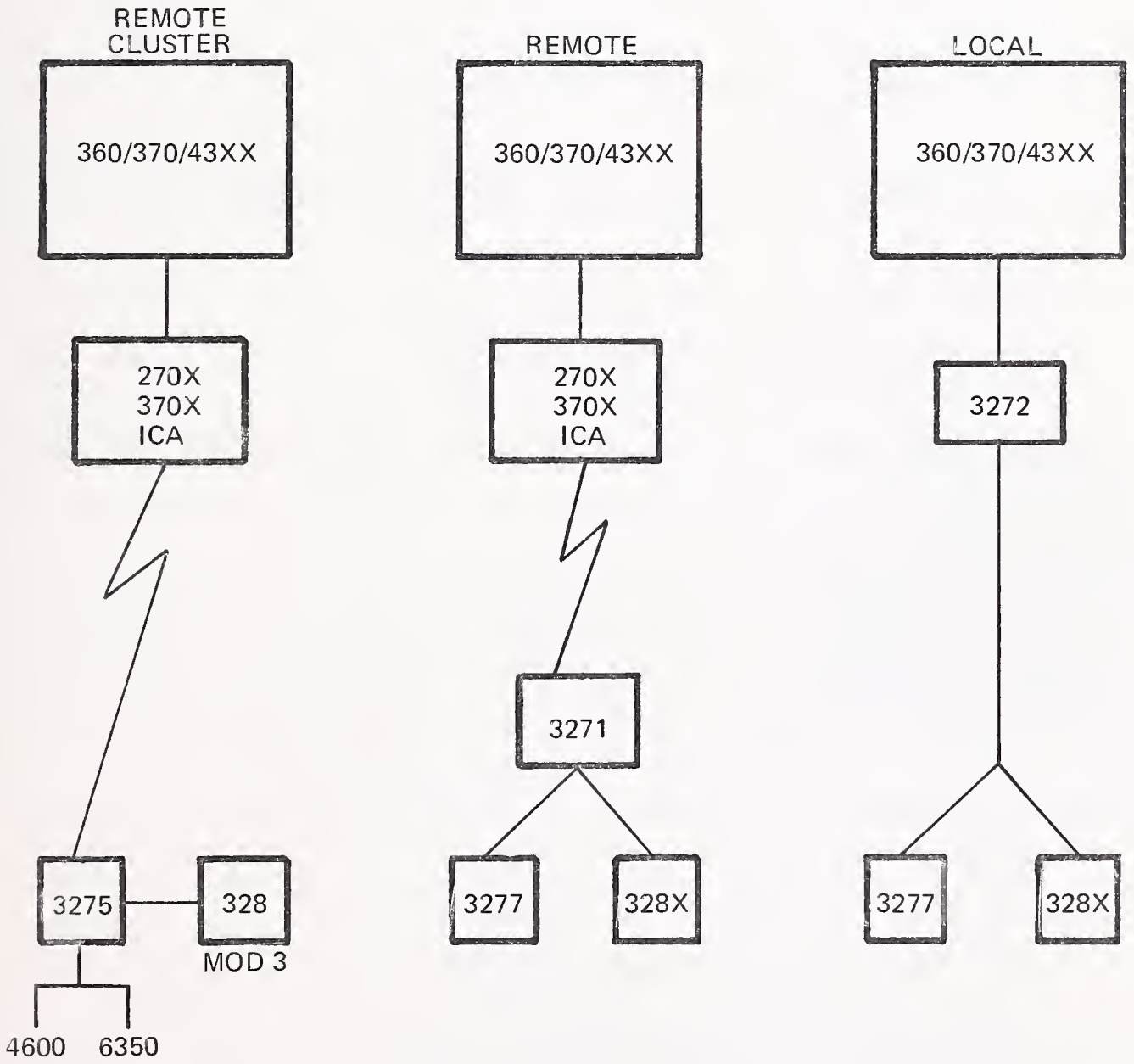
  - The ability of IBM to generate an unprecedented market demand for CRT's.

  - To establish the foundation for the remote cluster marker with the 3275 and the 3271.

  - To build upon the success of the 3270 IDS with new products and techniques in order to expand the worldwide CRT market at an even higher rate than in the middle to late 1970's.

EXHIBIT III-1

3270 INFORMATION DISPLAY SYSTEM (IDS)



B. THE 3274/76/78 IDS NETWORK

- In 1977 IBM announced that a new generation of products was being introduced into the 3270 system (see Exhibit III-2). The older products, were therefore obsolescent from that period on. The new products are:

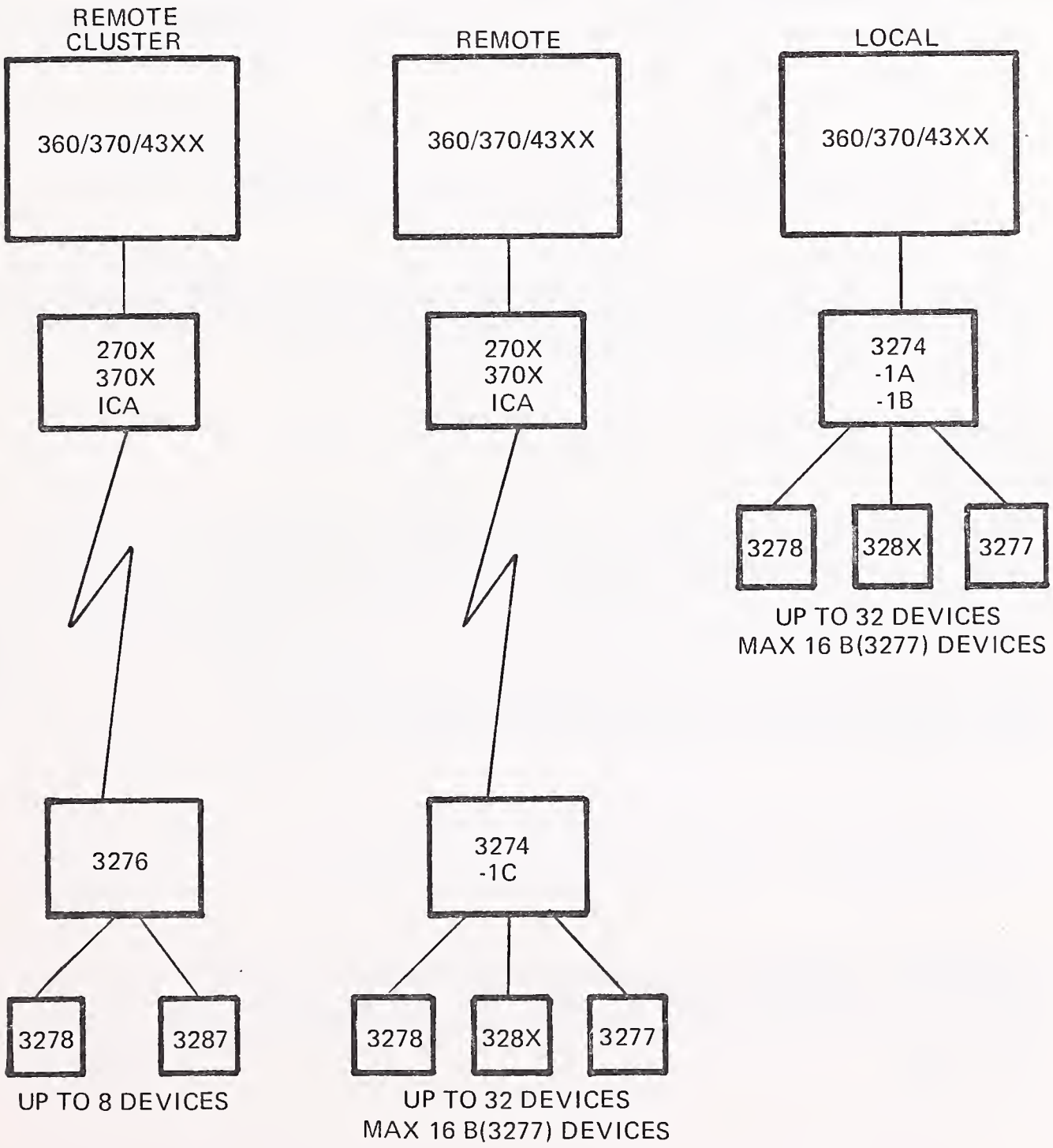
  - 3274 Controller.
  - 3276 Standalone Display Station and Mini-Controller.
  - 3278 Display Station, with 3274/3276 attach.
  - 3287 Character Printer, with 3274/3276 attach, or the 3271/3272 attach.
  - 3289 Line Printer, with 3274/3276 attach.

- There are five major areas where these new products differ from the older 3270 IDS units:

  1. Function.
  2. Mode of Operation.
  3. Interface.
  4. Price.
  5. 3278 Display Characteristics.

EXHIBIT III-2

3274/3276/3278 INFORMATION DISPLAY SYSTEM (IDS)



1. FUNCTION

- The first initial analysis indicates relatively few functions were added considering this is a new product announcement. For example, each 3278 has nine more keys than the equivalent 3277. These nine keys provide the following added enhancements:

  - Home key.

  - PF 13 through PF 24.

  - Dual speed cursor.

  - Local print when the 3278 is attached to the 3279.

- Obviously, IBM has built into the 3278 the ability to enhance the functional capability of the unit throughout the product life cycle.

2. MODE OF OPERATION

- The 3278 differes markedly from the 3277 in its mode of operation. When attached to a controller, a 3278 appears as two units, the keyboard and the display. Each time a key is depressed, the corresponding character or function code is transmitted to the controller. The controller processes the data and returns the character to the CRT for display.

- In effect, the intelligence has been moved from the display station to the controller. This is a major departure from IBM's previous systems design.

- Despite this apparent move of intelligence from the CRT to the controller, there is a very high number of logic gates contained in the LSI circuitry of each 3278.

- One possible reason is the use of redundant circuits to provide for soft failures. With each service call costing over $200, redundant circuitry would lower IBM's costs.

- Another possible reason for all the circuits is that unannounced functions are already built in.

3. INTERFACES

- The 3278 attaches to a controller with the same physical coax cable and connectors as does the 3277. It is here the similiarity ends, abruptly.

- The 3278 uses what IBM calls the "A" interface. It is current driven, as opposed to the "B" interface of the 3277, which is voltage driven.

- The coding scheme is also different. That is, the number of bits per character or code sent over the coax cable is larger for the "A" interface.

- IBM has not released the specifications on the "A" interface. It is not documented in any of their user or FE manuals. No independent CRT manufacturer has yet been able to deliver a 3278 compatible product, primarily because of difficulties in analyzing the design of the "A" interface coding structure.

- However, for this report such an interface document has been obtained and is provided in Appendix A.

4. PRICE

- Until the 3278 was announced, the 3277 was available by purchase or rental only. The average rental was $160/month and average purchase price of $4,200.

- When IBM announced the 3278, the rental price of the 3277 was dropped to approximately $130/month, and a two year lease was offered at $110 per month, a $50/month decrease to sign a two year lease. Purchase prices were lowered approximately 20%.

- More important, however, was the price of the 3278. The average two year lease price was reduced to an unbelievable price of $65 per month and an average purchase price of $3,850.

- The low lease/month price reflects IBM's decision to emphasize the financial advantage of base growth versus outright purchase for new product offerings.

- Control unit prices were almost doubled. However, these prices were offset by the lower CRT prices which appeared to the rental user as an overall price reduction.

  - For small remote clusters, the 3276 mini controller was introduced.

- This is, in actuality, a psychological market ploy by IBM where the CRT unit price is lower but the systems price higher, or the same, depending upon controller utilization.

5. 3278 DISPLAY CHARACTERISTICS

- The 3278 display is available in four models, all with 80 column format but with a varying number of lines.

  - Model 1 12 lines 960 characters.

  - Model 2 24 lines 1920 characters.

  - Model 3 32 lines 2560 characters.

  - Model 4 43 lines 3440 characters.

- Character display is by a varied dot matrix. A 7X14 character matrix is used for models 1, 2, and 3. A 7X11 matrix is used for the Model 4. For all models, the basic upper case letters are displayed with 7X9 matrix.

- The standard character generator for each 3278 (and 3276) display contains the character matrices for most countries served by IBM World Trade including the U.S. Proper keyboards must be ordered to use the character set for each country served.

- The Katakana character set and keyboard is a standard IBM option and can be ordered in Japan or other IBM World Trade countries.

- The Kanji character set is not supported.

- Display status information is displayed in a row of special graphics at the bottom of the CRT screen.

- The graphics include error indicators and a symbol showing whether the display station is attached to a 3274 or 3276.

C. IBM STRATEGY AND EFFECTS

1. 3278

- IBM's announcement of the 3278 had a dramatic effect. Within a short time after announcement, There were orders for as many 3278's as there were 3277's installed worldwide. The market exploded!

- IBM anticipated the market's response to their new product offering. Almost all 3277 users ordered 3278's, thus greatly expanding the market potential even though the product could not be delivered in quantity for another 12-18 months.

- To combat potential PCM vendors from eroding the current 3277 base and enfringing upon the 3278 backlog, IBM enacted a series of strategic moves.

  - Reduced the lease price of the 3277 and attempted to sign existing customers to two year leases.

  - Added customer requested enhancements to the 3278 - not the 3277.

  - Drastically reduced the price of the 3278 by using custom LSI and developing a highly automated manufacturing process to reduce labor content.

2. 3274/3276

- By moving the intelligence into the controller, IBM purposely made it difficult for a competitor to analyze and subsequently duplicate. Previously, many PCM vendors have successfully emulated IBM's 3277 display but few have duplicated the controllers.

- Lack of 3274/3276 controller documentation from IBM, compounds the problems of PCM vendors trying to enter this portion of the market.

- IBM's decision to use an abundance of custom LSI in the controllers, will not only delay early PCM entries but raise the spectrum of future IBM controller enhancements.

- The enhancements will be added one at a time and will be implemented in firmware.

- The rewards for IBM using custom LSI to reduce cost, further resulted in reducing the number and size of components.

- The 3276 with its mini-controller, for up to eight displays stations or printers, is contained within the same enclosure as the standard 3278.

- The controller is built entirely of custom LSI and contained in 2.5 cm square ceramic carriers on multilayer boards.

- Features for the 3276 and attached 3278's are added by swapping PCB's in the 3276. Apparently this is done to change the read-only-memory.

- The 3274 is similiar to 3276 in the design of PCB's and chip carriers.

- Unlike the 3276, the 3274 contains a floppy disc drive for microprogram loading.

- Features can be added to 3274 and attached 3278's by using a new floppy disc. Hardware changes are necessary only to add or change device adapters.

3. SYSTEMS IMPLICATIONS AND RISKS

- Exchange of data between the controllers and the CRT's is difficult to understand because of lack of IBM documentation.

- Problems will be encountered for any PC CRT vendor who wishes to develop a plug compatible 3278.

- One U.S. manufacturer, who has been working on a 3278 compatible device, has discovered that there are some differences between how a 3278 works with 3276 and with 3274 controllers.

- It is not fully known if this is intentional on the part of IBM or whether there are simply timing differences between the two controllers. U.S. PCM vendors believe it is a combination of the two.

- IBM's strategy is to protect its market from PC encroachment by:

  - Making documentation unavailable or at least difficult to obtain.

- Incorporating logic in custom LSI.

- Designing intelligence in only one unit of a cluster - the most costly unit to duplicate.

- Making it easy to implement design changes and add flexibility to the system when appropriate.

- Putting a severe strain on PC companies by cutting profit margins.

- Yet, the fact that IBM has put an integrated adapter into the 4331 has caused vendors, who previously offered non-interface compatible systems, to re-evaluate their positions. It may be necessary to duplicate the interface and offer a 3278 compatible unit now, although they originally planned to offer a system compatible only at the channel or communication interface.

- When U.S. vendors previously targeted the 3277 market, they were equally split in the way they approached the market.

  - Fifty percent built a 3277 compatible CRT which would run on IBM 3271 and 3272's.

  - The remainder designed and built CRT's which would operate only on their own contollers.

- Of those who built 3277 compatible displays, only one - TRIVEX - built control units compatible with both the 3271 and 3272 controllers. These took much longer to bring to market than anticipated because TRIVEX underestimated the overall task, although documentation was readily available from IBM.

- TRIVEX experienced problems in design and engineering; and even today their 3272 unit has performance problems compared to IBM. In addition, channel or line interface checks occur increasingly now that IBM is installing 303X systems with higher speed channels.

- The TRIVEX problem is particularly acute when computer operator displays are attached to the control unit.

D. THE EFFECTS OF IBM's NEW PRODUCTS

- IBM's new IDS product announcement has had a dramatic impact on the user and competitor alike.

1. IMPACT ON MARKET SIZE

- With rapidly rising labor costs coupled with double digit inflation, a low cost IBM display will gradually replace older 3277's and stimulate new applications. The ability to economically convert manual/mail systems to on-line systems will drive new orders.

- It is estimated that all U.S. PCM vendors will ship 275,000 units during 1979, up from 90,000 units in 1977. IBM will account for 175,000 units (64% of 1979 shipments). This is the U.S. market only.

2. CHANGE IN MARKET SHARE

- IBM's ability to be first with a new product along with industry setting pricing, will add market share to IBM's base.

- IBM's capability to counter competition during the critical staging period, (with lower 3277 pricing), before the new product can be delivered, has guaranteed the loyaltys of IBM's customer base.

- Through a combination of highly automated manufacturing facilities, custom LSI, vertical product integration and value added component synergism, IBM will be able to ramp 1979-1980 production while keeping product costs low and gross margins high.

- Assuming no component delays or unresolvable technical problems, IBM could build from 175,000 units for the U.S. market during 1979 to 225,000 in 1980.

3. REVENUE IMPLICATIONS

- Total revenue opportunities favor IBM rather than independent PCM vendors.

- The ability of IBM to stimulate market growth though new price/performance products wil benefit IBM directly.

- The 3277 base, estimated to be 450,000 worldwide units, will continue to provide excellent gross margins because of depreciated book value and continued demand. The demand remains high because the total market is expanding faster than new product can be delivered.

- Additional revenue will be generated by IBM through the outright sale of 3277's to users. As depicted in IBM's past actions, and as new products attain quantity shipments, IBM will greatly reduce the purchase price and allow accumulated purchase option credits (POC's) to be applied towards the lower purchase price.

- With accumulated POC's applied towards purchase, 3277's will be purchased in the range of $1,800-2,000.

- This strategy will provide IBM with additional cash, contain 3277 base erosion, reduce competitive actions, and, in effect, makes competition struggle for 3278 business. Competition must accomplish this with in some cases, an older and more expensive product of their own.

4. PROFIT PROJECTIONS

- IBM's profits from the new IDS products will accelerate sharply.

- IBM's product costs for the 3277 were approximately $700-800. The product cost for the 3278 is estimated to range between $450-500.

- There is no way U.S. PCM vendors can attain comparable product costs competing with IBM. If competitiors wish to compete for the 3278 market, IBM has already established "de facto" profits for competition. In essence, by pricing the 3278 at $63/month for a two year lease, IBM has regulated the gross margins for competition.

- Based upon projected volumes and anticipated market share, the majority of competitors will be hard pressed to achieve a $600-650 product cost.

5. COMPETITIVE ISSUES

- Regardless of the seemingly unsurmountable obstacles confronting the PCM vendors, the size of the CRT market will attract some formidable competition for IBM.

- In addressing this large and growing market, competitive vendors should consider the following key issues:

  - Slowness in reaching market due to undocumented "A" interface.

  - Difficulty in matching the low cost of the IBM 3278 display. Lack of volume prevents the same level of manufacturing automation.

  - Profit potential has been shifted from the high volume display to the lower volume controller.

  - Uncertainty about potential upgrades of IBM controllers - will software for the 3274 may become an item for which IBM will charge separately.

  - Competing across the product spectrum with a variety of IBM systems (3270, 8100 with 8775, System/38 with 5251) will be difficult.

- Ways to counter 3277 purchase business at $1,800.

- Ability to sell below IBM's 3278 price. Historically PCM vendors provide products at 15-20% less than that of IBM's lease or purchase prices. Assuming IBM will reduce manufacturing costs to $450-500, PCM vendors can only do this by giving up profit margins.

E. CURRENT IBM DISPLAY PRODUCT STRATEGIES

- The 3270, as it was originally introduced, was IBM's only general display system. It was sold as part of both of IBM's major computer systems - the System/370 and the System/3.

- By 1975, three major developments changed IBM's overall approach.

  - Significant penetration of IBM display market by PCM's.

  - Mini-computers being used increasingly in business applications, all using non-IBM displays.

  - Communication systems technology was maturing to the point that large networks supporting many types of terminals and processors were being planned.

- IBM's reaction to competitive pressures became a well executed, long term strategy adhered to even today.

  - Enter the commercial communications carrier business via SBS - Satellite Business Systems.

  - Enhance SNA to support large, complex networks.

- Ensure that each new terminal or processor be supported within SNA.

- Bring out a wide variety of processors to compete in a large segment of the mini-computer market - in effect, enter the distributed processing market.

- Introduce a variety of terminals and displays having different features and attachment protocols.

- To further illustrate IBM's orchestrated strategies, a product line continuum emerges consistent with and driven by IBM's desire to grow market share and eliminate competition.

  - The 3278, while ostensibly only an upgraded 3277, employs a new electrical and code interface to its control units. It uses the same RG62AU coax cable as the 3277 which gives the required speed and allows use of already in place cables.

  - The 8775 is the new display station for the 8100 distributed processor. It uses a different type of physical interface, a twisted wire pair, running in a loop from the processor, through each device on the loop and back to the processor.

  - Because the speed on the loop is limited to 38,400 bits/sec, each device must provide its own editing capability. In effect, each 8775 functions much as a 3276 controller with one display station. This arrangement relieves the 81XX of the task of processing each character.

  - The 5250 Information Display System is IBM's General Systems Division answer to the 3270. Intended for the System/34, System/38 and Series I processors, this display system has both local and remote versions.

- Up to seven additional devices attach to a base unit via coax cables. Architecture is similar to 3270 system but coding structure, particularly command codes, is different.

- The 4978 display station for the Series I is physically similar to the 5251 except that it has a blue display rather than a green one.

- The second major difference is the keyboard which has approximately 30 added special purpose keys. This display is intended to compete with the sophisticated displays provided by such vendors as Hewlett-Packard.

- This variety of terminals has, in effect, broken one large market into several markets, although the 3270 market alone is larger now than the one market of the past.

- By combining and slightly modifying basic components - CRT monitors, keyboards and custom LSI - which IBM manufacture in large volumes - IBM is able to supply displays for specific markets. Also, IBM is designing flexibility into products to provide the ability to enhance an existing product or introduce a new one if the market demands it or competition becomes too successful.

- It is anticipated that the product life cycle for the new 3270 product line will be six years. A replacement for the 3278 and its controllers will not be announced or delivered before 1983.

- The basic assumptions behind our projection that the present display technology will remain in place for six years, is based upon the following:

  - As with the 3270, a replacement product will not be introduced until after the System/H as been delivered.

  - IBM has too many products built around the 3270 hardware and software technology to obsolete them quickly.

- IBM has not yet reached maximum ship rate of 3278s and backlog remains high.

- Competitors have not kept IBM from increasing market share of display devices.

- No economical flat panel display of up to 3,000 characters will be mass-producable for another three to four years.

- From marketing and financial points of view, it makes no sense to obsolete the second generation when the first generation is generating excellent cash flow.

F. HARDWARE/FIRMWARE/SOFTWARE STRATEGIES (H/F/S)

- IBM has a very consistant method of structuring the Hardware/Firmware/Software (H/F/S) differentiation in their display product lines. This scheme is shown in Exhibit III-3.

- Software, which is user modifiable and which controls the data to and from the displays, resides in the host computer. This is consistent with the System/370, System/34-38, 8100, 4300, and Series 1.

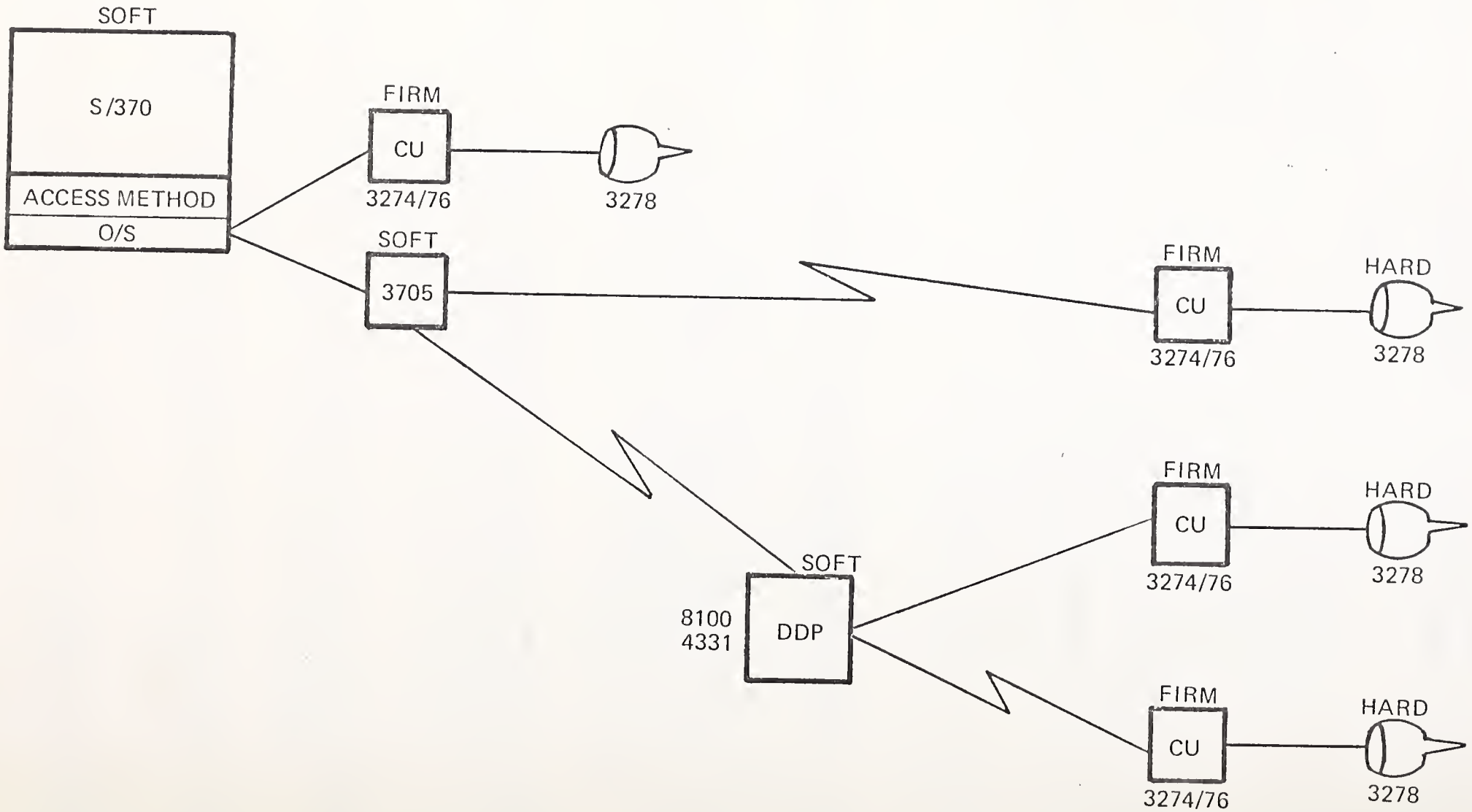
- Further, software enhancements or new software functions are being offered as program products.

- Users will not have access to the new functions unless they pay IBM to use the software.

- Both users and competing terminal vendors expect IBM to charge more for software products as IBM's market share increases.

EXHIBIT III-3

HARDWARE FIRMWARE/SOFTWARE INTEGRATION



- Firmware is used by IBM in both the host computer and the display control units. In the host, the use of firmware has two benefits to IBM:

  - It makes the software run faster and therefore commands a higher price.

  - Firmware is more difficult to copy and move from one CPU to another.

- In the control units, such as the 3274 and 3276, firmware will be used exclusively. It is not envisioned currently that users will be able to program these devices. However, IBM could provide a user programmable software capability should changing market conditions require such a decision. More likely, the customer requiring this will be steered to the 8100.

- The smaller controller, the 3276, will have factory determined firmware stored in PROM's. As noted below, erasable PROM's will be used for engineering changes in the 3276.

- The 3274 has a integral floppy disc drive. The firmware for each unit, including features, in distributed on a floppy disc. The user tailors the firmware to his own configuration requirements, and from that point on, loads microcode from the floppy disc.

- With the availability of the floppy disc and up to 128K bytes of memory in the 3274, the unit could be used as a user programmable device. We believe that this is not likely to occur.

- IBM could enhance the 3274 firmware so that it relieved some of the host software tasks. For instance, display formats that are frequently transmitted to the control unit for one or more of the attached display stations, could be stored on the floppy disc and recalled with a brief identifying code and command from the display operator or host program. This would reduce transmissions as well as host processing.

- Local format storage would be under control of host software. The user would not be able to program the controller.

- The display stations themselves are logically primitive devices that are totally dependent on the controllers for operation.

- IBM has chosen to make the 3278 with logic in custom LSI. It could also have been implemented with a microprocessor but IBM chose not to do so. It is, therefore a hardware device with no operating capability without a controller.

- A competing vendor could choose to make a 3278 compatible device with a microprocessor. Unless non-IBM compatible functions were offered as product enhancements, the processor would only be used to duplicate the IBM functions. Such a product would still fit into the IBM category of hardware device.

- There is no incentive for IBM to change its H/F/S strategy at this time. Treating the display as a hardware device keeps costs down by manufacturing a standard product. This keeps price pressure on vendors of competing products.

- By implementing the controllers in firmware, IBM has made the controllers difficult to duplicate, easy for IBM to modify or to add features, and capable of being upgraded with major features (local format storage) in the future.

- Keeping all the software in the host has, in the past, been a weak spot embodied within the IBM H/F/S strategy. But with the many modifications that are being made - most of which are now billable to the user - and with the possibility of putting those modifications into host firmware to prevent its use by PCM CPU manufacturers, IBM is using the software to its own advantage.

G. THE EFFECT OF THE 8100 AND 43XX PROCESSORS

- The introduction of the 8100 is one way in which IBM has shown its endorsement of the distributed processing concept. Orders for more than 25,000 8100 processors were taken within one month.

- Three months later, the 4331 and 4341 processors were announced. Many users ordered these units in addition to or inplace of the 8100's. The 4300 backlog exceeds 50,000 units today.

- With both types of processors on the market, large IBM users now have a choice of IBM methods to approach distributed processing. This comes at a time when computing and communications economics are beginning to favor dispersed processing.

- The result of these announcements has been, therefore, the creation of a huge new market for display stations.

- The following points are key to IBM's strategies:

  - The 8100 will support the new 8775 but it will also support the 327X IDS. A new model of the 3276 can be attached to the new local loop adapter. The older 3277s can also be attached.

  - The 433X processors support all the communications and display devices supported by the System/370. In addition, the 4331 has an integrated display adapter for up to 15 displays or printers without a control unit. It also has an integrated communications adapter for low cost communications with another CPU or with 3276s or 3274s.

- The 3270 family of displays is therefore the major benefactor of the new market opportunities.

- It will be several years (at least five) before IBM can deliver all the 8100's and 4300's in the backlog. During that time the ship rate for 3278/76 displays can be expected to increase each year.

- These products are indicative of IBM's movement away from the hierachical system network architecture to a new distributed architecture under the SNA banner.

- SNA itself will rapidly evolve to meet the requirements of the new distributed/dispersed processing users.

IV TECHNOLOGY

IV TECHNOLOGY

A. OVERVIEW

- When analyzing the circuitry of IBM's new IDS 327X devices, it becomes readily apparent that IBM has not advanced the state-of-the-art.

- Rather, IBM has implemented current LSI technology but with an over-abundance of LSI components performing redundant operations.

- Although the purpose for IBM's heavy utilization of LSI is not totally understood yet, two assumptions are presented:

  - Redundant circuits for reduced maintenance.

  - Future enhancement capability.

B. 3278 TECHNOLOGY

- There is a commonality of LSI packaging for both controllers and CRT's. Chips are packaged in 2.5 cm square ceramic carriers. There are up to four chips per carrier and 26 chip carriers with up to 400 gates per chip. The exact number of gates is still unknown and quite possibly the gate density is even greater than 400.

- Initially, it was believed that IBM used a microprocessor in the 3278 design. Now, this does not seem to be the case.

- Investigation by one leading PCM vendor indicates the 3278 design utilizes fixed logic implemented with LSI.

- The fixed logic provides the required fast response times necessary, in selected communications activities, to reply to polls from the control units.

- Analysis of the 3278 indicates there is additional memory above that required for conventional display functions.

- The 3278-2 has more than 1920 characters of memory. The additional number of memory characters beyond 1920 is not currently known and their purpose and/or functions is unclear. Other models also have more memory than characters displayed.

- The 3278 is connected to either the 3276 and/or the 3274 by a RG62AU type coax connector. The transmission bit rate on the coax is 2.3587 MH_Z.

- Data transmission is performed in 12 bit words. The first bit is a synchronization or start bit. The last bit is an even parity bit.

- Groups of words are contiguous with the synchronization bit of the next word immediately following the parity bit of proceeding word.

- Response time of the device to the control unit is critical. It is mandatory that the 3278 respond to the control unit within 5.5 microseconds after completion of a WRITE type command or after receiving a READ type command.

  - The significance of timing dictates the synchronous bit of the first word of the response must be sent not more then 5.5 microseconds after the parity bit of the last word has been received.

- This speed requirement apparently precluded the use of a microprocessor in the 3278 design. Recognize that the design was completed in the 1976-1977 time period.

- Rather, the 3278 uses fixed logic implemented with bi-polar gate-array technology. It is not clear whether the internal logic is TTL or ECL. Conceivably it could be a combination of technology that is used in the 43XX processors and controllers. IBM will integrate similiar technology throughout various but similiary performing units, to achieve value added cost/performance goals.

- The logic implemented in the 3278 is segmented into three phyisical categories:

  - Coax interface.

  - Memory.

  - Internal control functions.

- It becomes necessary to isolate the coax logic in order for the interface to handle the responses to the control unit within the required 5.5 microsecond period.

- The keyboard and the display are internally interfaced to the control section of the logic.

- Each of these three segments (coax, memory and internal control functions) is contained in a single PCB.

- The single PCB design, which comprises each of the physical categories, allows IBM to make model changes among the 3278-1, 2, and 3.

- 3278 model changes, for models 1 through 3, could be performed by a user at the users' site should IBM elect to provide this option.

- 3278 model 4 changes require a change to the character generator/control as well as the memory PCB. This will be a field engineering implemented upgrade.

C. 3276 TECHNOLOGY

- The 3276 control unit supports up to eight devices within the housing of one 3278 display station.

- The space occupied by the 3276 PCB card cage and coax connector is simply empty in a 3278.

- The 3276 design encompasses a microprocessor. At this time, the origin and specifications of the microprocessor are unknown.

- As can be expected, specifications of 3276 PCB's and chip carriers, are the same as the 3278.

- The 3276 control unit operates in a poll/address mode. When a key is depressed at the display station, the appropriate data or control code is sent to the control unit. When multiple devices are attached, the control unit must service all devices within the alloted time period.

- The high data rate on the coax interface and the fast response times required of the 3278, are necessary to allow the control unit to keep up with the eight devices.

- One PC vendor interviewed by INPUT determined that when a 3276 is writing long blocks to one device, and is concurrently handling READS at maximum typing speed from four displays, the 3276 can be overloaded.

- When this situation occurs, the 3276 cannot respond properly to the host over the communications link, a time-out occurs and an error condition develops.

- The error condition is recoverable and is seldom likely to occur. However, the fact remains that this problem can occur. IBM must either correct this condition or live with potential user criticism about reduced throughput performance.

- Like the 3278, the 3276 controller is segmented into several logical functions at the PCB level. These logical functions are:

  - Communications adapter.

  - Microprocessor.

  - Memory.

- The communications adapter has its own PCB.

- The microprocessor PCB contains all the control unit logic other than memory.

- Memory for the 3276 processor is contained on three Read-Only-Storage (ROS) PCBs.

- The ROS design provides the provision for changes without disturbing the basic ROS PCB's. A separate PCB is known as the Patch Read-Write-Storage (RWS). The RWS PCB uses multiple 20 pin sockets for standard ROM's.

- A recently manufactured 3276 at the now current EC level, contains an Intel 2708 UV ROM IC with a label over it indicating the EC number.

- Embodied in the RWS ROM design, is the provision for automatic address mapping of the firmware patches contained in the ROM onto the basic firmware contained in the ROS.

- An advantage for this provision is that it allows for very fast and inexpensive field/user upgrading of units and quick EC level changes in the manufacturing process.

- Like the 3278 design, IBM has incorporated into the 3276 design, the flexibility and versatility to meet systems changes while at the same time, quickly and inexpensively incorporating EC changes during normal maintenance periods.

D. MONITOR TECHNOLOGY

- The display monitor, used in the 3278, is basically the same device incorporated in 3277.

- Although somewhat larger than other PCM vendors' CRT's, IBM has been successful in marketing this unit against competitiors smaller CRT's.

- IBM's decision to continue with the 3277 type CRT, in the 3278 unit, is based solely upon an economic decision. The 70^{o} tube used by IBM gives high resolution at low cost.

- Another important economic decision relates to maintainability. The 70^{o} tube is very stable in operation and normally requires less alignment than the 110^{o} tube.

- However, IBM continues to experiment with finding the untimate path between resolution, performance and cost. While the 3278 continues to use the successful green phosphor (P39), IBM has announced a blue phosphor CRT for the Series/1.

E. EFFECTS OF IBM's TECHNOLOGY

- IBM's extensive use of LSI in a variety of new displays (3278, 5250, 8775 and 4978) will provide IBM with five key benefits:

  - Economical design and flexibility.
  - Low manufacturing costs.
  - Low service costs.
  - Value added in other products.
  - Economies of standardization.

- IBM has developed the industry's most advanced computer automated design system.

- As a result, IBM can develop the masks for the gate-array LSI in a very short time period. This capability gives IBM the means to fragment the CRT market by offering a variety of displays with different interfaces and operating characteristics.

- The concentrated use of LSI, coupled with the low cost and inherent reliability of the 70° CRT, provides IBM with the means to set world market CRT prices. It is estimated the high volume manufacturing costs for the 3278 will be approximately $450-500.

- IBM service capabilities are the standard of the industry. Much effort has been expended by IBM to reduce total service costs while still maintaining service leadership.

- IBM has continuing dedication to service leadership. Reducing mean-time between-failures (MTBF), and Mean-time To-repair (MTTR) periods, is being accomplished through the following programs:

  - Reduction in service calls through reliability with LSI and additional circuit redundancy. This program is not relegated exclusively to the 3278 but probably encompassed within all recently announced IBM products wherever practicable. For example, the average service call costs approximately $200. An increasing amount of redundancy hardware can be designed and built into products to reduce service calls which are becoming more expensive each year because of rising labor/inventory costs.

  - Shortened service call periods by integrating service diagnostic aids into the units. It will become more apparent with time, that all manufacturers will provide self diagnostic aids to achieve acceptable MTTR periods. IBM will actively foster such programs with the industry following.

    - IBM has already begun to experiment with user installation, user diagnostic, and user repair programs.

  - Spares costs can sometimes be the difference between profit and loss for a field engineering organization. IBM's standardized packaging of PCB's thoughout for the 327X IDS units, not only guarantees IBM reduced spares costs, but the costs of the spares themselves are dramatically reduced through the use of LSI technology.

  - Customers and users of 327X units will be required to do much of the service including the original installation. In future periods, self-diagonic-problem-solving (SDPS) will be encouraged to lower maintenance rates should the customer elect to participate in the optional SDPS program.

- Although not currently and readily apparent, IBM will standardize LSI components, wherever possible, to achieve value engineered cost reductions. As newly announced IBM products are delivered, the technologies analyzed and the commonality of products understood, INPUT believes that most competitors will have underestimated the degree of component standardization implemented by IBM.

F. PCM VENDORS' ASSESSMENT OF IBM TECHNOLOGY

- U.S. PCM vendors view IBM's dedicated use of the LSI as no threat to their ability to successfully target and infiltrate the IBM 327X IDS base.

- Our survey indicated that 37% of the vendors believed the only advantage of LSI technology for IBM was product cost and, therefore, price. Evidently the majority of PCM vendors have not yet conducted enough design analysis of IBM's 327X IDS units to forecast on-going IBM actions.

- It should be noted however, that no U.S. vendor has delivered a display station capable of attaching to the 3274 or 3276 "A" adapter interface. One exception is Memorex which is rumored to show this capability at the National Computer Conference (NCC) in June 1979.

- By implementing the logic in LSI, and not releasing detailed documentation until forced to do so, IBM has made it difficult, but not impossible, for vendors to compete with the 3278 directly.

G. FUTURE TECHNOLOGY

- For the new units in the 3270 system, IBM uses custom LSI. Throughout, these LSI chips are in multi-chip carriers, 2.5 cm square. It is probable, but not

certain, that the microprocessors and other specialized circuitry in each unit have been developed using IBM's gate-array technology and computer assisted design system.

- IBM's CAD system allows a system designer to develop logic based on preprogrammed subroutine circuitry while working at a display station. The CAD system produces documentation and "E" Beam masks for the final metallization layers on standard gate-array chips.

- It is estimated that packaged chips are available for testing in not more than ten days after the designer completes his specifications at the display station.

- INPUT is trying to determine which gate-array chips are being used. Also, the type of logic, MOS or ECL, is to be determined.

- The cathode ray tube will be the primary display device for the next five years. It is used in each of IBM's new displays. It is stable, low cost to manufacture and can handle displays of many characters.

- Also, IBM will stay with the 70^{o} CRT. It is low cost, has high resolution with relatively little need for adjustment. Any cost above that of the 110^{o} CRT's used by most of IBM's competitors, is probaly made up for in reduced service calls to adjust/align the unit.

- Flat display have two major drawbacks:

  - High cost.

  - Limited number of characters in display.

These two factors are related and each involves the thousand-wire problem. To get a large display requires hundreds of connections on each edge. Thus far, there is no satisfactory method to automate making the connections. It is a manual operation with prohibitive costs.

- Only limited size flat displays have been practical to date. But work continues on gas-discharge and LCD displays by IBM and many other vendors.

- Most observers believe someone other than IBM will bring the first flat display product to market in the IBM display marketplace. It will be high priced and find a small but devoted market.

- When several vendors can offer such a product (1983-85), IBM will also enter the market. Not until they are forced to do so, however.

- A more significant short range threat from IBM is the color CRT display. IBM is known to have a major effort underway using color monitors. They have already placed an order for several hundred color monitors from a Japanese manufacturer.

- The initial product will probably be a high cost graphic terminal. However, it is possible that some of the unknown or now unused codes in the "A" interface, may allow a color display (the 3279?) to be added to the 3270 system in the future.

- This could have a limited number of colors; e.g., green, red, and white - such as the Fujitsu 9525 - and command a 25% or more higher price.

V OPERATING ENVIRONMENTS

V OPERATING ENVIRONMENTS

A. SYSTEMS NETWORK ARCHITECTURE (SNA)

- Systems Network Architecture (SNA) is still an evolving product within a strategically defined framework. For many large users of data communications and IBM mainframes, the most significant benefit from SNA has been the ability to use SDLC - the full duplex line protocol.

- A unique characteristic of domestic U.S. lease line traiffs accounts for the desirability of a full duplex protocol. Namely, the communications user is charged no more than ten percent for a full duplex line over the price for a half duplex line. Therefore, SDLC was the only major economic benefit offered by IBM with SNA.

- Converting an existing network and attendant applications to SNA can be extremely expensive.

- Currently, less than ten percent of IBM communications users have elected to implement SNA, including SDLC, in a live working environment.

- An additional ten percent have tried or are trying to test SNA with varying degrees of success. Results to date indicate that most promising results are centered on new applications.

- Conversions of older programs and/or upgrading of terminals to SNA is too costly. The benefits derived from reduced line costs are not enough to offset reprogramming and additional hardware equipment costs, and additional support and training costs.

- IBM has finally acknowledged the reluctance of the user to embrace SNA. As a result, IBM has enticed users with additional incentives in the guise of the Advance Communications Functions (ACF).

- ACF provides users with the ability to interconnect terminals and display stations to programs in one or more CPU's within a given network.

- Additional incentives by IBM to convert to SNA, allows 3270 BSC users to also take advantage of the CPU network connections.

- In essence, a dramatic but subtle change has been enacted by IBM. They are now actively selling the benefits of ACF as opposed to the previous, but seldom realized benefits of SDLC.

- SNA is not a defined product. Rather it is an IBM strategy built around a communications framework. The objectives and derived benefits available to IBM from implementing SNA strategies are as follows:

  - Consolidate all communciations developments into two defined products, namely, VTAM and SDLC. Currently, IBM supports over 30 communications access methods and more than 20 lines protocols.

  - Capture a larger share of the communictions terminal market with SNA. Prior to the announcement of System/370 and 3270 IDS, IBM terminals and displays accounted for only 40% of the total units attached to IBM CPU's.

INF

- With the announcement of the new 327X system and the 303X CPU, IBM's strategy was to increase market share of terminals attached to IBM processors from 40% to 60% by 1981.

- Along with the new terminal and CPU announcements, IBM commenced to aggressively sell SNA and emphasize the new terminals.

- The majority of the terminals were designed to work with SNA - SDLC only. User reluctance to readily embrace SNA forced IBM to provide BSC mode support as well.

- SNA provided the capability to interface terminals and CPU's together in a common network.

- It can be expected as IBM moves again towards a variety of CPU types, coupled with a growing population of new terminals, it becomes increasingly dersirable for IBM to allow all units the same line protocols and message procedures as defined by the SNA disciplines.

- Competitive impacts must be minimized. In the U.S. marketplace, IBM recognizes AT&T as the most formidable threat. AT&T's in-depth resources, plus their dedication to achieve dominance in the data communications markets, influences IBM's strategies tremendously.

- IBM will concentrate on converting users to SNA and dedicated networks before AT&T can gain market momentum with their Advanced Communications Service (ACS).

- Once a user has converted to SNA, ACS is not an alternative because reprogramming costs would be prohibitive and because the private network is already in operation.

- From AT&T's view, their strategy for selling against IBM and SNA will be:

- Lower conversion costs to ACS.
- Support of all types terminals and CPU's within ACS.
- Ease of network implementation.
- Complete user flexibility and minimal dependence upon IBM.

- Other possible competitors to IBM, particularly in the minicomputer and/or terminal markets, are reluctant to confront SNA. Not only are they concerned about taking IBM head on and the tremendous resources required, but IBM's past history of continually announcing new products and upgrades to existing ones keeps competition at bay.

- IBM will evolve SNA from a dogmatically hierarchical network, controlled only by a host CPUT, to a distributed network architecture. This will allow 8100's and 4300's to be used as node processors. Software to implement this will all be billable, and it will permit IBM users to effectively use distributed data processing (DDP).

- As a result, IBM's strategic minipulation of SNA and its ability to control users, places SNA as a strong defensive weapon as well as a superior offensive weapon.

B. DISTRIBUTED DATA PROCESSING (DDP)

- IBM can be expected to expand their sphere of influence most aggressively into the Distributed Data Processing (DDP) markeplace.

- The recent announcements of various small processors such as the 8100, 43XX, System/38, and Series I are prime examples of IBM's dedication to achieve market superiority in DDP.

- Like the new 327X IDS family of devices, the DDP entries utilize a commonality of components, most noticeably the new IBM 64K RAM for main memory and common peripheral units. The combination of common memories throughout, coupled with interchangeable peripherals, not only results in reduced product costs but provides an abundance of product mix to thwart competition.

- Large, inexpensive memories are necessary for DDP. The SNA control procedures, whether in an access method such as VTAM and NCP or in new software for the 8100 and the System/38, require large amounts of memory.

- Only by providing large amounts of inexpensive memories will IBM be able to direct DDP into the SNA environment - from a customers' perspective.

- Without an available and acceptable SNA, IBM has been most reluctant to pursue the DDP market. Previously, it has been too easy for a user to interface a non-IBM minicomputer as a distributed processor using bisync or even an asynchronous protocol.

- This situation is rapidly changing. Now, that IBM is fostering the concept of DDP, many users will be influenced and begin seriously considering DDP. IBM will ensure that only SNA users will be able to assimilate the new DDP system.

- Satellite Business Systems (SBS) is part of IBM's strategy to additonally develop business in the U.S., and, potentially, in foreign markets.

- SBS will support data, voice, video and facsimile. Further, it is expected IBM will support SNA users and actively guide them towards SBS services. Non SNA users will experience more problems in utilizing the SBS attach.

- All the above compelling reasons will force IBM to make SNA an accomplished market success. IBM will devote whatever resources are required to ensure the success of SNA. A series of announcement are planned to guarantee market acceptance and customer implementation.

- However, SNA will not come free. On the contrary, the customer will pay handsomely for the cost of software to offset lower hardware prices and reduced revenues.

- This strategy allows IBM to exert price pressures on all PC vendors. Vendors are reluctant to incur software development costs but would rather allow their users to run IBM's available software offerings.

- IBM will be expected to counter by moving from readily available software to increasingly more comprehensive software that is costly and/or difficult for vendors to run on their equipment.

- The end result will see SNA usage growing to where over 50% of all communications users will be using SNA by 1983.

C. SYNCHRONOUS DATA LINK CONTROL (SDLC)

- IBM's dedication to SNA means that SDLC will become the predominant line protocol by 1985.

- Vendor and user surveys indicated SNA and SDLC are not key issues in the marketplace today. However, both groups agreed that SNA is rapidly becoming an important part of their planning.

- Users indicated that new applications would spark the use of SNA and SDLC. By 1981, vendors must provide SNA compatible products to survive in this market sector.

- When objectively analyzing SDLC, three deficiencies were preceived by several users interviewed.

- SDLC allows for only seven blocks to be transmitted before a response must be received. For satellite transmission, seven blocks are inadequate and results in transmission delays. IBM has indicated a special fix is available which allows for 127 blocks to be outstanding. A permanent change is much further away. Some satellite carriers provide a special additional processor referred to as "satellite delay compensation device."

- SDLC uses the GO-BACK-N ARQ error correction technique. This requires that the sending unit repeat a block that was not received correctly plus all succeeding blocks up to a maximum of seven. Many users have requested that IBM change to an error transmission technique which provides for retransmission of only a specific block.

- SDLC is similiar but not idential to HDLC. Complete compatability between SDLC and HDLC would permit SNA users to more easily tie into X.25 compatible networks. Since that would be contrary to IBM's intention of directing customers to only SNA, it is highly unlikely IBM would readily offer to make SDLC compatible with HDLC.

- With the exception of IBM, of course, the user and vendor evaluations of SNA and SDLC are as follows:

  - SNA is extremely costly to convert to.

  - SNA will be initially selected for new applications only.

  - SDLC provides important transmission cost savings although there are admitted deficiencies even within SDLC.

  - Users are moving to, and vendors are beginning to provide for, SNA and SDLC.

- Binary Synchronous Communications (BSC) will continue to be used for many years despite the movement towards SNA.

- Through 1978, less than five percent of the installed 3275s and 3277s attached to 3271s, used SDLC. However, the usage is growing quickly. Ten percent of 3276s and 3278s shipped during 1979 will be going into an SNA environment. This percentage will grow to 20% by 1980 and to an overwhelming 90% by 1985.

VI FORECAST OF FUTURE PRODUCT LINES

VI FORECAST OF FUTURE PRODUCT LINES

A. OVERVIEW

- Until the 3274/3276/3278 announcement, IBM had been a considerable - although not a dominant factor in the 327X world market.

- Prior to shipments of the new 327X IDS products, IBM accounted for approximately 36% of the total installed CRT devices and 75-80% of installed 3277 type displays.

- However, with the new 327X IDS announcement, IBM set in motion a chain of events which will lead to an increasing share of the world's data communications markets.

- IBM's overall strategy will revolve around the total market's acceptance of System Network Architecture (SNA). While very few manufacturers can generate new markets for their products, IBM has the ability to both generate a new market and to manage its direction over an extended period of time.

- PC vendors, AT&T not withstanding, will untimately have to support SNA which will become a de facto standard.

- While AT&T's presence could be favorably influenced by complimentary federal legislation, AT&T's overall ability to successfully combat IBM head on

is highly speculative. AT&T's dilemma derives from its unwieldly organization structure and lack of competitive hardware products.

- Other vendors, such as minicomputer manufacturers, may fare better when competing with IBM. These vendors will not imperil or challenge IBM's dominance of the market. They will however, find unique opportunities consistent with their product strengths and IBM's inability to totally saturate all market segments. The principal market/product thrust developed by the PCM CPU vendors will be at the rapidly emerging distributed processing segments.

- The independent PC CRT systems vendors such as Courier, Telex, Computer Optics, Memorex and Ratheon will, like their mainframe and minicomputer counterparts, be forced under IBM's network umbrella.

- As IBM creates an increasing market demand for DDP and display devices, the 327X compatible vendors will each strive to increase their market share. These vendors must be constantly on the alert to derive their increased market share from IBM, rather than from each other.

- The compatible 327X vendors, as well as the other contenders, will <u>not</u> provide new and innovative products. Rather, it is IBM who will:

  - Set new product standards.

  - Select the network criteria.

  - Determine competitive price levels.

  - Establish "de facto" profit margins for competition.

  - Control the market shares of the competition - not likely to exceed 40%.

- To successfully compete against IBM, PCM vendors and 327X systems competitors will:

  - Provide compatible products.

  - Price such products from 10% to 25% under IBM.

  - Bundle pricing for selected software should IBM unbundle new 327X IDS software offerings.

  - Allow customers "trade-ins" on previously purchased products, or transfer purchase-option-credits from the older to the new product lines.

  - Encourage lease upgrades, without penalties, from older 327X products to newly announced 327X IDS units.

  - Establish aggressive financial/sales programs to "assest swap out" purchased IBM 3277's for competitions new products.

  - Investigate mergers, acquisitions and/or distribution channel arrangements (especially with foreign vendors), to maximize resources and capabilities.

- In any event, little, if any, innovative product announcements will emanate from competing vendors against IBM's new 327X IDS products.

B. DISPLAY STATIONS

- IBM will continue to divide the total display station market into segments based on the processors the displays are attached to coupbled with varying user requirements.

- The 3278 display station will undergo few significant enhancements during the life of the product. Feature enhancements will be made to the controllers, particularly the 3274.

- If a new requirement were to be demanded by the market, it could be added to the 3278 by using the spare key that is not now used.

- The most likely major enhancement, either to the 3278 or as a new product (3279) will be the introduction of limited color capability. This could be done with two or three colors or as many as eight.

- While special purpose displays will increasingly use flat plane gas discharge tubes, it is not expected that the CRT will be replaced in the early 1980's as the predominant display device.

- Many users are today requesting keyboards with non-standard layouts of functions. This trend will continue. We may see keyboards with interchangable key caps and user selectable key locations become available.

- PCM vendors who offer added capability stand a better chance of taking market share from IBM than those who do not. Without this added capability, the vendor will be forced to compete on price alone.

- IBM will continue to make display stations be "Customer Setup Units (CUS's)". This will be accompanied by built-in, foolproof diagnostics.

- The next step will be self-maintenance, with the customer doing all maintenance, up to and including swapping PCBs. In the short term, customers will not maintain the power supply or the monitor.

- Display enclosures may be available in a variety of colors to match office backgrounds.

- These comments apply to the 3276 as a display station.

- Limited graphics capability may be added to the 3278 but probably not with solid lines and curves. Rather it will be characters (X's, etc.) in rows and columns under software (host) control. IBM may offer a version of Tektronix's display storage terminal to its customers who need solid line displays. IBM is using literally hundreds of these terminals internally today.

C. CONTROLLERS

- The 3276 controller will not have significant changes during its life. With the ability to support both BSC and SDLC already at up to 9600 bit/sec, only minor changes would be requested or required by any users.

- Limited upgrades are possible by (user?) insertion of PROM IC in the RWS PCB mentioned above.

- The average cluster size to be supported by the 3276 will be between three and four displays.

- The 3274 will probably be enhanced - just when competitors are beginning to get a share of the 3278 market. The most likely major enhancement will be the local storage of screen formats.

- Formats would be loaded from the host and selected by host software or the display operator. This will save transmissions and host processing.

- It is unlikely that the 3274 will ever be user-programmable.

- The remote model of the 3274, Model 1C, will be upgraded to permit transmission speeds of 19.2K bit/sec.

- The average number of displays and printers to be supported by local 3274s, Model 1A and 1B, will be between 16 and 20.

- The average number of displays and printers to be supported by the remote 3274s will be 12-16.

D. SYSTEMS

- The 3270 Information Display System is intended to be just that - a display system. It is not a processing system.
- Control of the system will be maintained by host software.
- For the 3270IDS, the H/F/S demarcations are as follows:
  - Dislays and printers are hardwired.
  - Controllers are firmware driven.
  - Software in the host controls the system.
- The 3270 IDS can be considered to be the low end of a line of systems, for example:
  - 3270 - 128K - No user programming.
  - 8100 - 512K - Programming for limited applications.
  - 4300 -- 1 Megabyte up - General processing capability.
- Each of these systems can directly control display stations. But the more processing capability, the more a system is restricted in the number of devices supported as a controller.

- The 3270 IDS is supported by both the 8100 and the 4330; it is likely that it will also be supported by the (as yet unannounced) "H" Series large scale machines. Thus, it is capable of being used by a very wide range of IBM CPUs and software.

E. FEATURES

- IBM will provide new 3270 features by providing new firmware for controllers.
- Few features will be added to the 3278 display itself - if IBM can avoid it.
- On an RPQ basis, IBM will supply keyboards with customized layouts. For example:
  - Ten key numeric pads.
  - TAB keys in different positions.
  - Characters moved to different keyboard positions.
- A PCM vendor can gain market share by offering more willingness to provide such features than IBM.

F. COMPETITOR TYPES

- The 3270 IDS has three basic type of competitors:
  - Plug compatible (PC) vendors of individual components. PC displays will work on IBM controllers and sometimes IBM displays will work on PC controllers; e.g.:

  - . Memorex.
  - . Genesis One.
  - . Telex.
  - . Trivex.

- System compatible vendors. Displays typically work only with vendors own controllers; e.g.:
  - . Courier (ITT).
  - . Raytheon.
  - . Computer Optics.
  - . Sycor (Olivetti).

- System vendors who provide 3270 compatibility in addition to other processing; e.g.:
  - . Four Phase.
  - . Datapoint.
  - . Sycor.
  - . Harris.

- There are advantages to each approach. Each type of vendor feels he made the right choice for the 3277.

IN

- Now that the 3278 will be supported directly on the 4331, the second type of vendor will emphasize a PC display.

G. MARKET FORECAST

- The projected shipments and installed base for 3270 type displays are shown in Exhibit VI-1.

- The installed base figures show that few 3277 type displays will be retired in the next three years. Shipments of 3277s will continue to be strong until manufacturing of new units can catch up.

- While IBM has stopped shipping new 3277 type displays, some PCM vendors are still building them. For 1979, these represent apporximately 14% of the total shipments. By year end 1981, shipments will drop to zero.

- IBM is known to have a second production plant already open for communications products, including displays. Including their older Raleigh plant, they will move from a capacity run rate of 100,00 units per year to a run rate of approximately 225,000 units per year, by year end 1979.

- IBM delivery time for new order of 3278s has dropped from 18 months in June 1978 to 6 months today.

- All plug compatible manufacturers have added significantly to plant capacity since the introduction of the 3278 and the market explosion it caused.

- IBM will account for about 65% of all shipments in 1979 and 1980. IBMs share will slip to 50% by 1983 or 1985 as the PCM vendors increase ship rates.

- When IBM's share does drop below the 55% level, they will likely announce a follow-on product.

EXHIBIT VI-1

327X DISPLAY STATIONS,

SHIPMENTS AND INSTALLED BASE FORECAST

(ALL FIGURES IN THOUSANDS OF UNITS)

REGION	1978		1979		1980		1981	
	SHIP-MENTS	INSTA-LLED	SHIP-MENTS	INSTA-LLED	SHIP MENTS	INSTA-LLED	SHIP-MENTS	INSTA-LLED
U.S. ONLY	150	415	275	685	350	1,030	400	1,420
NON-U.S.	125	290	240	525	350	860	450	1,275
TOTAL	275	705	515	1,210	700	1,890	850	2,695

- Although the 8775 could be considered a specialized 3276 type display, intended only for the 8100, it is not included in Exhibit VI-1. 8775 shipments will total less than 5,000 in 1979 but will grow to about 75,000 in 1981.

- The projections in Exhibit VI-1 are consistent with the data from the vendor survey and with other recent surveys. Most prior surveys of this market have consistently underestimated the annual ship rate by 30% to 50%.

H. IMPLICATIONS AND COMMENTS

- The growth of the 3270 market will continue for the next three or more years.

- Market growth will be limited by the availability of processors, specifically by the availability of 8100s and 4300s. (These, in turn, may be limited by the availability of discs in large enough quantities.)

- "H" Series, IBM's to-be-announced line of large processors, will not be available in quantity until 1981. It is expected that the "H" Series will support even larger networks of 3270's and of follow-on display products.

- The 3270 display market is the fastest growing of all the IBM display markets.

VII USER AND VENDOR QUESTIONNAIRE

VII USER AND VENDOR QUESTIONNAIRE ANALYSIS

A. OVERVIEW

- The purpose of INPUT's user interview program was to measure and evaluate each user's plans and anticipations in light of their anticipation of IBM's actions.

- Although IBM would not be interviewed, answers and views by their customer base provide a good reflection of IBM's probable direction for the next three to four years.

  - These views, while indicative but not conclusive, sustantiate both user expectations and vendor perceptions of IBM's major product and market strategies for the ensuing years.

B. USER EXPECTATIONS AND NEEDS

- Eleven diverse users were queried, respresenting varied industries with different installed and on-order equipments.

- Particular study emphasis was directed to user equipment selection criteria, present equipment usage, and future application needs.

- Consistent answers from all users indicated:

  - SNA would be implemented during the next two years.

  - Price, reliability and service continue to be the dominant reasons for selecting equipment.

  - The new IBM 327X IDS units are expected to play an important role in the users on-going application plans.

- Seven separate industry segments were sampled to determine key motivational trends and future plans. These were:

  - Process manufacturing (3 interviews).

  - Discrete manufacturing (2 interviews).

  - Public utilities (2 interviews).

  - Services (1 interview).

  - Insurance (1 interview).

  - Banking (1 interview).

  - State government (1 interview).

- Some of the answers provided by the users are of an open ended nature and yielded highly qualified responses.

- Many of the results and conclusions complemented prior research work conducted by INPUT, specifically the following studies:

  - Distributed Data Processing Systems.

- New Hardware Economics.
- IBM 4300 Impact.
- IBM 8100 IMPACT.
- Users Plans.
- Data Base Management Systems.
- Plug Compatible Mainframes.

I. PROCESS MANUFACTURING

- Users in this industry segment currently have a combination of 3277/3278 terminals installed.
- Two of the three users will continue with IBM products while the remaining one will select another vendor (Harris).
- The IBM users indicated that price, reliability, support, and maintenance were the principal reasons for continuing with IBM.
- The non-IBM user indicated his decision was influenced by the additional terminal features provided by Harris.
- Vendor change, according to two of the three respondents, would occur only if the vendors' products were poorly maintained, unreliable, or excessively priced.
- SNA plans were varied. One user indicated no plans to proceed with SNA. The second user indicated plans were presently undetermined, while the third user stated he was not moving towards SNA.

2. DISCRETE MANUFACTURING

- The two respondents have a combination of 3277/3278 units currently installed. One user indicated that additional new IBM 327X IDS units are on order while the second user is still evaluating future hardware and vendors.

- Both users stated that vendors are selected on the basis of reliability and service. However, they did differ on other selection criteria. One stated the importance of access protocol and the other indicating the need for equipment to match the application.

- Reasons for changing vendors found common agreement, namely, lack of equipment availability, high cost and maintenance problems.

- Both users stated they would implement SNA to improve efficiency of host computers.

3. UTILITIES

- The two utility respondents are deeply committed to IBM's product lines.

- Reliability, service, price, and systems compatibility are the key factors which influence their decision to continue with IBM.

- The only reasons for leaving IBM would be a combination of poor service, lack of compatibility and high cost/performance ratios.

- SNA will be readily embraced by both utility companies although one user indicated SNA is merely "a marketing ploy," and the other acknowledged "pressure" to implement SNA.

- The remaining four users, representing the service, insurance, banking, and state government sectors, varied considerably in the type of equipment installed and on order.

- Equipments installed included Computer Optics, Memorex, NCR, Four Phase, and IBM. No apparent loyalty to IBM was evident in the group. Rather, they expressed satisfaction with present vendors and planned continuation of existing vendors product lines.

- All concurred that price was the major factor which influenced their buying habits. This was followed closely by service and reliability.

4. OTHERS

- As might be expected, the mixed bag of five users were split in their views regarding eventual use of SNA.

- The user of NCR terminals, along with his NCR CUP, has already cast his lot and SNA will not be available to him unless he elects to embrace IBM.

- Two of the five indicated no firm plans had been yet formulated regarding their companies' decision to enter the SNA area.

- The remaining two companies showed definite interest and justified their planning actions based upon reduced line costs, error correction, and the ability to link with SBS for additional data rate efficiencies.

C. PCM VENDOR PERCEPTIONS

- It is always revealing to compare the perceptions of users and vendors in market research project of this type. In this case, both were asked to rank their perception of the most important characteristics of display terminal vendors. The results are shown in Exhibit VII-1.

EXHIBIT VII-1

COMPARISON OF USER AND VENDOR PERCEPTIONS
OF MOST IMPORTANT CHARACTERISTICS
OF DISPLAY TERMINAL VENDORS

RANK	USERS	VENDORS
1	SERVICE	COMPATIBILITY
2	PRICE/PERFORMANCE	PRICE/PERFORMANCE
3	RELIABILITY	CUSTOMER SUPPORT (OTHER THAN MAINTENANCE)
4	COMPATIBILITY	COMPANY REPUTATION
5	PRODUCTS TAILORED TO MATCH APPLICATIONS	PRODUCTS TAILORED TO MATCH APPLICATIONS
6	CUSTOMER SUPPORT (OTHER THAN MAINTENANCE)	
7	COMPANY REPUTATION	

- For any vendor wishing to enter the PCM terminal marketplace, the users weighted responses differed somewhat from the vendors perception of what is important.

- The users overwhelmingly indicated in order of importance that: service, price/performance, reliability and compatibility became the most important factors when selecting equipment.

- On the other side, the vendors perceived the users equipment decisions are based upon: compatibility, price/performance, customer support and company reputation.

- On the whole, vendors either underestimated or were not aware of the importance the users placed upon service and equipment reliability.

- Both vendors and users alike agreed that price/performance and compatibility were key in the equipment decision process. The indifference of the vendors to recognize the importance placed by the users on service and reliability decision factors, has an adverse impact on their ability to achieve market pentration.

D. IBM's PROBABLE ACTIONS

- IBM's superior market/product experience will continue to dominate and confuse aspiring PCM vendors market penetration efforts.

- While U.S. PCM vendors struggle to find the key to unlock IBM's hold on the 327X marketplace, IBM continues to set competitive standards for service, price, reliability, and products tailored to the customers future needs.

- The best PCM's can offer is to follow with "me too" products, emphasizing prices 15-20% under IBM and targetting user customers who are either anti-IBM or willing to take a risk.

- Limited market opportunities will exist for PCM vendors who can capitalize on IBM's inability to meet surging market demand deliveries, and when IBM elects not to provide unique hardware/software features for special applications.

- Special market opportunities may exist for overseas vendors where:

  - IBM is constrained because of nationalistic favortism which may have tariff protection.

  - Competitive labor rates, coupled with advance technology to provide users with price/performance products substantially below that of IBM.

  - Special hardware/software features and systems tailored to those emerging markets not totally understood by IBM.

E. OLIVETTI: 270 AND SYCOR 250

- The Sycor 250 is an intelligent terminal targetted to sell in the 3275/3277 market.

- Sycor discontinued the 250 in 1978.

- A year ago, Sycor was acquired by Northern Telecom, an operating company owned by Bell Canada. Northern Telecom also owns Data 100.

- With these acquisitions, Northern Telecom is poised to make a strong entry into the IBM PC market in particular and in distributed processing, in general.

- Northern Telecom will also aggressively pursue both horizontal and vertical product integration strategies leading ultimately to a strong position in the "Office of the Future" market.

- INPUT believes that Northern Telecom will focus marketing in the U.S. and Canada only.

- The Olivetti 270 is a Sycor 250 sold by Olivetti in the New York and New Jersey area. Customers are primarily government groups such as police and banks. Although Olivetti had some initial success with the product it was too expensive to compete with 3276/3278 and the line has been replaced with a new terminal, the 280.

- The 270 is a 250 with a special interface permitting Olivetti to add their own printer, card reader and OCR wand.

- The 280 is a dumb terminal, separate controller system configured (in a systems sense) similar to the 3276/3278 and is meant to compete directly with IBM. Olivetti claims sales are good among their entrenched clients in the New York/New Jersey area.

- Both the 270 and 280 fully support SDLC.

- Olivetti's success with the 270 and 280 can largely be attributed to a samll group of very excellent sales people in New York.

- Olivetti recently signed an agreement with Memorex to sell their 1377 Mod 4 in Italy. Olivetti has an option to manufacture this terminal in Europe.

VIII SUPPORT RELATED ACTIVITIES

VIII SUPPORT RELATED ACTIVITIES

A. SOFTWARE

- All major IBM software systems and packages support the 3270. In fact, they assume that the major user terminal will be the 3270.

- The exceptions to this are terminals for specific industries (for example, PSO) or RJE type devices and the software to support them.

- IBM has invested hundreds of millions of dollars in software supporting the 3270 IDS.

- Users have invested billions of dollars in software systems based on use of 3270's.

- With that kind of investment, IBM cannot afford (and the users will not allow) to easily replace the 3270 IDS, with a non-compatible system.

- IBM will evolve its software to use 3278 features such as PF13 through PF 24, and potential features such as screen format storage in the 3274. This will be done slowly because the 3277's are not going to disappear quickly; IBM does not want them to disappear while they are profitable.

- Because of the almost universal use of 3270 type displays on IBM processors, and the existing IBM support and customer expertise, a 3270 PCM vendor does

not need to have a large or very experienced software support staff to sell or install display stations.

B. APPLICATIONS

- IBM is primarily a supplier of general purpose systems. Only for very large customers have they built systems consisting of special hardware and the software to support it. Examples would be military systems or the airline reservation systems.

- The 3270 is not now, and is not expected to become, application dependent.

- SNA, (VTAM) will continue to support 3270 systems in both the BSC and ADLC mode. Therefore, the line protocol used will not be a factor in application development.

- Enchancements to the 3274, which have already been mentioned, will not be application dependent.

C. MAINTENANCE

- Field service is the most critical support related activity.

- User surveys indicate that good service is a primary qualification of a PCM vendor.

- The best service is provided by high reliability. IBM is building greater reliability into their display products.

- Users expect, and most vendors provide, two hour maximum response time to service calls. This certainly limits the number of locations that can be serviced by a PCM and therefore limits potential market size.

- Service is usually provided by replacement of major components such as PCBs or the monitor.

- For large accounts or in locations where two hour response is not possible, vendors leave spare units on-site.

- The number of spares left on-site is usually 1/25th of the total units installed at the site. There is no decrease or increase of the maintenance charge for the installed untis. The customer is responsible for replacing the failed units and for notifying field engineering of the situation.

- In a few cases, the customer maintains the displays. Failing components may be repaired by user personnel or returned to the vendor for repair at normal OEM rates. This type of service normally is limited to government installations.

- Maintaining display stations themselves does not require a high level of expertise. But when a unit is fixed or replaced and still does not "work" from the customers point of view, higher level support is required.

  - The problem may be in the display, the control unit, modems, front-end or host processor. It may be hardware or software that is not working correctly.

  - A vendor who does not have at least one field engineer at each service location and who is capable of finding and correcting such problems, can get a reutation for poor service despite the infrequency of such situations.

- The problem may eventually be found to be in the modern or the application software, but is is the display vendor who is remembered concerning the problem.

- The service organization must develop good working rapport with users and with the IBM field engineers.

IX SALES TERMS AND CONDITIONS

IX SALES TERMS AND CONDITIONS

A. IBM

- U.S. PCM vendors must follow the general contract sales terms and conditions established by IBM.

- Over the past 25 years, IBM has acquiesced - through government and competitive pressures - to allow the following major contractual changes:
  - In 1956, agreed to sell products in addition to the historical lease only policy.
  - In 1970, introduced the multi-year lease.
  - In 1976, offered a four-year fixed-price system lease.
  - In 1978, provided a residual trade-in value for model 158s to counter emerging PCM CPU vendors.

- Several U.S. equipment manufacturers, including the federal government, have attempted to prove that IBM is conducting unfair market practices and stifling competition. To date, IBM has been successful in fending off these court actions as well as tying up the government court case in a myrid of counter moves.

- When the time is appropriate for IBM, they will probably allow the government a graceful exit by agreeing to superficial consent decrees. This will provide the government with a face-saving decision. In the long run, it will have little impact on IBM's continued and aggressive marketing practices.

B. PCM VENDORS

- PCM vendors will continue to work within the sales terms and conditions fostered by IBM.

- Vendors will provide innovative and flexible terms and conditions encompassing:

  - One year leases.

  - Contractual upgrades to new product offerings with existing contracts and without incurred penalities.

  - Guaranteed trade-ins on previously purchased units for new product offerings.

  - Transfer of purchase-option-credits on old products to new products.

  - Three, four, five, and six year leases with upgrade capability to other similiar products.

- Exhibit IX-1, Sales Terms and Conditions, highlights the contractual offerings of IBM and the PC vendors.

EXHIBIT IX-1

SALES TERMS AND CONDITIONS

TERMS/CONDITIONS	IBM	OTHERS
• MONTH TO MONTH RATE	X	X
• 1 YEAR LEASE RATE		X
• 2 YEAR LEASE RATE	X	X
• 3, 4, 5, 6 YEAR LEASE RATE (NON CPU'S)		X
• UPGRADE WITHOUT PENALTY		X
• TRANSFER PURCHASE-OPTION-CREDITS (OLD TO NEW)		X
• GUARANTEED TRADE-IN (PURCHASE BUSINESS, NON-CPU)		X
• PURCHASE CONTRACT, INCLUDING CONDITIONAL SALE	X	X
• PURCHASE CONTRACT WITH NO-DOWN, BALLOON PAYMENT		X
• INVESTMENT TAX CREDIT (ITC)	X	varies

APPENDIX A: IBM 3276 INTERFACE SPECIFICATION

IBM 3274, 3276 Control Unit to Device
Product Attachment Information

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October , 1977

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PREFACE

The IBM 3270 Information Display System is a family of display products that can be tailored to meet the needs of most alphameric display applications. The 3270 system has three basic categories of Components:

Control Unit
Display Station
Printer.

This Original Equipment Manufacturer's Information Manual provides information on the interface and Input/Output from the control unit to the display stations and printers.

The control unit interface is described for the IBM 3274 Control Unit and the IBM 3276 Control Unit Display Station. The control units are generally used with the following devices:

IBM 3278 Display Station, Models 1, 2, 3, and 4
IBM 3287 Printer, Models 1, and 2

The 3278 Display Station may optionally be equipped with a Selector Light Pen and a Magnetic Slot Reader.

TABLE OF CONTENTS

SECTION 1. TRANSMISSION ARCHITECTURE

.0 INTRODUCTION

The 3274 Control Unit is used to control and support up to 32 display stations and/or printers. The 3276 Control Unit Display Station is used to control and support up to eight display stations and/or printers. However, the 3276 is supplied with one attached display station. All device functions are controlled by the control unit (3274 or 3276). Commands provide for Read, Write and physical operation of the attached devices. Separate buffers in the display terminals and printers receive, hold or transmit data and commands. In addition, status information from the attached devices is monitored and logged.

1.1 GENERAL TRANSMISSION ARCHITECTURE

Data is transmitted from a control unit to a device or device to control unit via a single coax line, per device. The coax type is RG62AU with a maximum length of 1.5 kilometers. Data is transmitted as serial bits using a binary dipulse technique. (See paragraph 3.0 for coax transmission protocol.)

Data is transmitted over the coax at a bit rate of 2.3587 MHz. in the following format:

Twelve (12) bits are assembled to form one (1) twelve (12) bit word for transmission in either direction over the coax. The first bit of the twelve (12) bit word is used to delimit successive words from the control unit and is always a "one (1)" bit and will be referred to as the "Sync bit". The last bit of each twelve (12) bit word is the parity bit that will maintain even parity when added to the preceeding eleven (11) bits.

Word groups of twelve (12) bits each may be contiguous. In this case, the sync bit of the next word must directly follow the parity bit of the preceding word with no intervening pad bits. A word from the control unit to the device (display or printer) may be either a command or a data word. Each Write type command will cause a Transmission Turnaround/Auto Response (TT/AR) following the last word of each group of contiguous words sent from the control unit, and the device responds with clean status (bits 1 and 12) if the word(s) was (were) received without a Transmit Check. A word from a device in response to a Read type command may be either data or a status word. The device must begin response (data, status 5/78 | or TT/AR) within 5.5 microseconds after receiving the ending sequence from the control unit (both read and write type 5/78 | commands.) The 5.5 usec. is measured from the end of the last bit time of the received ending sequence to the

eginning of the first bit time of the transmitted
tarting sequence.

he 12 bit command word from the control unit to a device
ontains address bits and a command code. The address
ortion of the command word is three bits in length (Bits
,3,4) when addressed to the device base unit and four
its in length (Bits 2,3,4,5) when addressed to a feature
f the base unit. This provides five bits for command
odes (Bits 5,6,7,8 and 9) to the base unit and four bits
Bits 6,7,8, and 9) for command code to a feature.
eserved bits in all commands and responses must be zero.

.2 WORD FORMATS

OMMAND WORD TO BASE UNIT.

1	234	56789	10	11	12
YNC	000	XXXXX	0,1	1	X
IT	ADDR.	CMND	*	CMND.	Parity

Bit 10 is reserved

OMMAND WORD TO FEATURE.

1	2345	6789	10	11	12
YNC	XXXX	XXXX	X	1	1
IT	ADDR.	CMND.	*	CMND.	Parity

* Bit 10 is a parity bit (odd) for the preceding 8 bits

ATA WORD TO BASE UNIT OR FEATURE (Bit 2 is most significant)

1	2345	6789	10	11	12
YNC	XXXX	XXXX	X	0	0
IT	DATA	WORD	*	Data	Parity

* Bit 10 is a parity bit (odd) for the preceding 8 bits

Data words of less than 8 significant bits will be right justified (by the control unit) and the high-order bits set to zero.

TATUS WORD TO CONTROLLER (see also paragraph 1.4.2.2)

1	2345	6	7	8	9	10	11	12
YNC	XXXX	X	0	X	X	0	0	X
IT	ADDR	(		STATUS	BITS		)	PARITY

OR:

1	2345	6789	10	11	12
SYNC	KEYBOARD		1	0	X
BIT	SCAN	CODE			PARITY

A status word is always sent (in response to a POLL command) from a device that has power on and has completed its POR sequence. A response of all zeros except for bits 1 and 12 indicates that there are no error conditions to be reported and no operator activity requiring service.

This response will be refered to as "all zero" or "clean" response. If bit 11 is set, bits 2-10 are undefined.

DATA WORD TO CONTROLLER (Bit 2 is most significant)

1	2345	6789	10	11	12
SYNC	XXXX	XXXX-	P	0	P
BIT	DATA	WORD	*		Parity

*Bit 10 = Parity bit (odd) for the eight bit (2 through 9) data word for Read Data and Read Mult. commands to the Base address, and any Read command (with bit 8 set to 1) sent to a feature.

Data Words of less than 8 significant bits will be right justified (by the device) and the high order bits set to zero.

1.3 ADDRESS BIT ASSIGNMENTS

1.3.1 Address Bits (2, 3, 4, 5) for a Command to a Device

2345		
CCCX	0,1	BASE OR KEYBOARD
0010	2	SELECTOR PEN
0011	3	Reserved
0100	4	MAG. STRIPE READER
0101	5	Reserved
0110	6	Reserved
0111	7	Reserved
1000	8	Reserved
1001	9	Reserved
1010	A	Reserved
1011	B	Reserved
1100	C	Reserved
1101	D	Reserved
1110	E	Reserved
1111	F	ESCAPE

1.3.2 Address Bits (2, 3, 4, 5) of Status Word from a Device

0000 BASE UNIT

All other features have the same address bits in a status word response as shown for command words to a device.

1.4 COMMANDS

1.4.1 Device Base Address Read Commands (Bits 5, 6, 7, 8 and 9)

READ COMMANDS (XXXX1)	56789
56789	XXX11: Response Parity Checked
	XXX01: " Not " "

00001	POLL
00011	READ DATA
00101	READ ADDRESS COUNTER HIGH
10101	READ ADDRESS COUNTER LOW
01001	READ TERMINAL I.D.
10001	POLL/ACK
10011	Reserved -
01101	READ STATUS (Security key and other switches)
11001	Reserved
01011	READ MULTIPLE
10111	Reserved
01111	Reserved
00111	Reserved
11011	Reserved
11101	Reserved
11111	Reserved

Note: Spare and Escape commands. In response to the spare Read commands the device will return an all zero data word with bad parity (bits 2 through 10 all zero) regardless of bit 8 in the Read command.

1.4.2 Read Command Functions (to Base)

1.4.2.1 00001-POLL and 10001-POLL/ACK

The poll command (Hex 1) does not use the address portion of the command word for address. Bits in address portion are assigned as follows:

Bits 2 and 3 are encoded as follows:

For Display:	For Printer:
11= Enable keyboard clicker	11= Enable Operation*
01= Disable keyboard clicker	01= Disable Operation*
10= Sound alarm	10= Sound alarm**
00= None of the above	00= None of the above

* A "special Poll" to the printer to control the half-duplex operation of the printer. "Disable Operation" will cause the printer to stop internal operations as soon as possible (10 msec max), return "Op. Complete," and wait for subsequent control unit commands. The Printer will 'No-Op' the disable poll if the printer is already disabled. "Enable Operation" will revert the printer to internal operation. The printer will continue the operation in process prior to the "disable." Enable Operation must be sent upon completion of Control Unit command sequences to allow new status to be presented to the control unit. The maximum disable time will not normally exceed 60 seconds. The printer must not load (or add) any pool status (except POR response) after becoming disabled. The device must be capable of accepting successive enable or disable polls. The control unit must not send 'enable' (or Start Op

Command) while waiting for a response to a previous 'disable'. If 'disable' state occurs prior to completion (or termination) of an order, the control unit is not allowed to alter the control unit output area or load a new order, except 'Abort'. If Abort order is loaded, Start Op, rather than Enable, must be sent.

Note: The printer is also Enabled by 'Start Op' and 'Reset' commands (1.4.3) and Disable (within 100 usecs) by the setting status bit 6,or 9 (Poll response) or POR response (1.4.2.2).

Note: Prior to disabling, the printer will set the printer Address Counter to '0000'.

To allow for control unit error recovery, the printer must appear enabled to the control unit immediately (within 20 usec) upon receiving the 'Enable' Special Poll.

Exception: The printer must no-op the 'Enable' function if the Poll Response register is non-zero. Refer to Section 2.0.

** The Sound Alarm Poll will not alter the Enable/Disable state.

Bit 4= Reserved
Bit 5= ACKnowledge last input message to control unit.

1	2	3	4	5	6	7	8	9	10	11	12
SYNC BIT	X (see	X above)	0	X	0 (	0 Poll	0 cmnd	1)	0	1	P

Bit 10= Reserved

The response word to a poll is a one word status response. The Poll Response is returned for any combination of bits 2, 3, and 4 in the Poll command. Since the poll is not addressed to the base unit or any feature, a priority for response is established by having the base unit respond with its status. If a non-zero status word is sent to the control unit, the device will anticipate receiving a Poll/Ack to acknowledge the acceptance of the first status word and cause the device to respond with "clean" status and reset the previously returned status bits. Upon receipt of the clean status response the control unit may issue another Poll, without the Ack bit, and the device will respond with the second status word. If the second poll does not have the ACK bit on, the device will respond with the first status word again even though higher priority status may have become available. Reset and Read Terminal ID commands sent to a device after it has returned non-zero status but before the status was ACKnowledged will cause certain status

bits to be reset. Refer to Reset and Read Terminal ID commands.

Note: 'Op complete' status, and 'Feature Error' status, can also be retreived by the 'Read Status' command. Op Complete status, or Feature Error status, will be reset by the 'Read Terminal ID' command, as well as the Poll, Poll/Ack sequence described above.

Note: The Control Unit must issue the Poll/Ack command with bits 2,3 and 4 set to zero.

The Poll command is received and decoded in the base logic. The priority of Poll response is:

0 Feature Error (Bit 11)
1 POR complete Special status code.
2 Base Status (Bits 6,8,9) *
3 Keyboard (including keyboard overrun) Scan Code
4 Any other Feature Status

* Multiple bits of base status may be returned in a pool response. If a base status Bit is returned and not ACK'd, the same bit will be returned in the next poll response. Other base status bits will not be returned until the control unit ACK's the original returned status.

Exception: The Display will add bit 9 to previously returned base status bits if an Op Complete condition occurs and a poll is received prior to receipt of a Poll/Ack.

Exception: The Printer is allowed to add base status bits to previousl; returned base status. If there is no base or feature status to send, an all zero poll response is sent from the base unit indicating that service is not required at the device.

Note: While the base display is busy, the display will suppress all status. See paragraph 1.4.3 Clear Command. Upon completion of the Busy operation, bit 9 will be set in base status.

1:4.2.2 Response to Poll (Status Words)

The status response word from the device base unit is:

1	2345	6	7	8	9	10	11	12
SYNC BIT	0000 ADDR	STATUS TRANS	SPARE 0	DEVICE CHK	OP CPLT	KYBD IND	FEAT. ERROR	PARITY BIT

Bit 1 = Sync Bit

Bits 2, 3, 4, 5 = Base address

Bit 6 = For Displays: Status transition has occurred. Refer to Read Status command.

For Printers: Status Available. This bit is set by the printer when new status is loaded or when status bit 4 is cleared in the printer status register. Before setting this bit the printer will set the Address Counter to 0000. After setting this bit the printer will go disabled. The Control Unit is responsible for reading status (address 0000) prior to sending enable. This bit is also set (and the above sequence occurs) periodically to test the communication link. Refer to section 2.4.

Bit 7 = Spare

Bit 8 = Parity error has been detected in storage. When Ack'd, display will not respond with another Device Check until after the next Write Data, Clear, or Reset command; printer until after the next command from Control Unit.

For printers: Bit 8 set signifies that a parity error occurred during a search or clear command. Bit 9 will also be set.

Bit 9 = A. A search has been completed.
B. A clear command has been completed.
C. An Insert Byte command has been completed. (Display Only)
D. A 'Disable' Poll has been completed. (Printer Only)

Bit 10 = 1 Redefines bits 2 through 9 as being a keyboard code or additional base status. Keyboard scan codes will be entered with Bit 2 the make/break bit, and Bit 3 the high order bit of the 7 bit scan code. See section 4.4 for specific code points. Non make/break keys will enter scan codes with bit 2=0.

Special status codes are:

2345 6789

X000 0000 DISPLAY: Keyboard overrun.
X000 0001 Spare
0000 0010 Power On Reset (POR) response.
Device has powered on since last Poll.
This code is sent only in response to
a Poll received after a power on (or Reset command)
sequence is complete. Also, for Printers: Following
internal test during which controller communication
was suspended for a minimum of five seconds.
X000 0100 Spare
X111 1111 Reserved for control unit use
1000 0010 Reserved

5/78

Bit 11 = Feature Error Bit This bit will be returned when a feature error is set. This bit will be reset

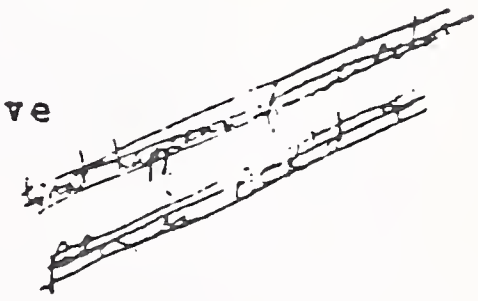
by Poll/ACK or Read Terminal ID. When bit 11=1, bits 2-10 may contain garbage and should be ignored by the control unit. Refer to paragraph 1.4.4 for additional description of the Feature Error Bit.

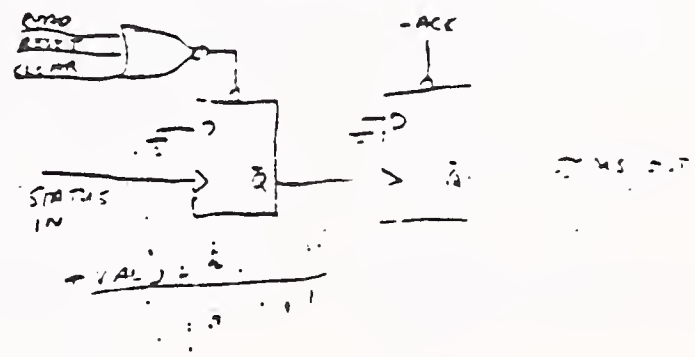
While set, the features are blocked. ACK will only reset the Feature Error Bit, other base status pending will not be reset. Bit 11 is not set by printers.

Bit 12 = Parity Bit - maintains even parity of the preceeding eleven (11) bits.

1.4.2.3 Feature Poll Response

Individual Status Bits will be returned until ACK'd by a subsequent Poll. Following receipt of the ACK, the feature will not return the same status bit until positive action (Read, Reset, Clear, etc.) has been taken to service the status. (Printers will not generate any Feature Poll response.)





SELECTOR PEN Status

1	2345	6789	10	11	12
1	0010	X000	0	0	P

Bit 6 = Request Read
Bit 7 = Spare
Bit 8 = Spare
Bit 9 = Spare

MAGNETIC STRIPE READER Status

1	2345	6789	10	11	12
1	0100	X000	0	0	P

Bit 6 = Request Read
Bit 7 = Spare
Bit 8 = Spare
Bit 9 = Spare

1.4.2.4 Other Read Commands (to Device Base)

Each of these commands will cause the device to return one or more Data Words. The ending sequence will follow the 12th (P) bit of the last Response word.

00011 READ DATA

The read data command will cause the addressed device to respond with one data word from storage at the current I/O address counter value. The

address counter steps up (increments) once at the completion of the command.

01011 READ MULTIPLE

This command will cause the device to respond with one or more data words from storage beginning at the current I/O address counter value. The read will terminate (with ending sequence) when the two low order bits of the I/O address counter step to 00. A maximum of four bytes will be returned.

This command will be no-op'd by the printer.

10101 READ ADDRESS COUNTER LOW

This command will cause the device to respond with one data word. Bits 2 thru 9 of the data word contain the present value of the 8 low order bits of the address counter.

00101 READ ADDRESS COUNTER HIGH

This command will cause the device to respond with one data word. Bits 2 thru 9 of the data word contain the present value of the high order bits of the address counter (right justified).

01001 READ TERMINAL I.D.

This command causes the device to respond with one data word.

Note: This command will reset Op Complete and Feature Error status (bits 9 and 11 in Poll Response.)

The format of the response data word is as follows:

DISPLAY

1	2	3	4	5	6	7	8	9	10	11	12
Sync Bit	Keyboard I.D.				Model			0	0	0	P

PRINTER

1	2	3	4	5	6	7	8	9	10	11	12
Sync bit	0	0	0	0	0	0	0	1	0	0	
(				Printer				)			

Display (bit 9=0, bits 6,7,8 ≠ 0)
Bits 2,3,4,5 = A/N Keyboard I.D.

0000 Reserved
1000 DATA ENTRY 2 WITH NUMERIC LOCK
1001 DATA ENTRY 1 WITH NUMERIC LOCK

1100 DATA ENTRY 2 WITHOUT NUMERIC LOCK
1101 DATA ENTRY 1 WITHOUT NUMERIC LOCK
1010 Reserved
0010 TYPEWRITER, NUMERIC LOCK
1110 TYPEWRITER, UP TO 88 KEYS
0110 Reserved
1111 NO Keyboard
1011 Reserved

Bits 6,7,8
000- Reserved
001- Screen size 960
010- " " 1920
011- " " 2560
111- " " 3440
101- " " Spare
110- " " Spare
100- Escape

Printer (bits 2 thru 8 = 0, bit 9=1)

Terminal ID of a printer will be obtained by reading address '000C' of the printer buffer. Refer to paragraph 2.2.5

1101 READ STATUS

This command will cause the device to respond with one data word as follows:

Bit

2=0 - Mono Case switch turned off
2=1 - " " " " on

3 Reserved

4=1 Not Busy* (Refer to Clear command)

5=0 - Security key turned off
5=1 - " " " on

6 Spare

7=1 Feature Error Bit ***

8=1 Op Complete**

9=0 - Security key turned on (display on)
9=1 - " " " off (display blanked)

5&9=0,0 - Security key not installed.
5&9=1,1 - Invalid code.
0,1 - Security key off (Display Blanked)
1,0 - Security key on (Display on)

*Other bits are valid only when bit 4=1. For Printers: Bit 4=0 when Busy or Enabled.

**Set when Op. Complete set in base status. Reset when ACK received to Op Complete poll status (Poll/Ack sequence) or Read Terminal ID Command received. For Printers: Op Complete Poll Status, set as a result of a disable Poll command, may or may not be returned as Read Status Op Complete.

*** Set when Feature Error Bit is set in base status. Reset when ACK received to Feature Error poll status (Poll/ACK sequence) or Read Terminal ID command received.

Transitions of bits 2,3, or 5 and 9 will cause the display to return bit 6 in Poll Response.

For Printers: Only bits 4 and 8 are implemented.

1.4.3 Device Base Address Write Commands (Bits 5, 6, 7, 8, and 9)

WRITE COMMANDS (XXXX0)
56789

00000 Reserved
00010 RESET
00110 CLEAR
01100 WRITE DATA
01010 LOAD CONTROL REGISTER
00100 LOAD ADDRESS COUNTER HIGH
10100 LOAD ADDRESS COUNTER LOW
01000 START OPERATION
11010 SPARE
11100 SPARE
01110 INSERT BYTE
11000 SPARE
10000 SEARCH FORWARD
10010 SEARCH BACKWARD
10110 LOAD MASK
11110 Escape

Note: The Spare and Escape Write commands will reset the previous command, unless busy. If no other command or data word directly follows the Spare command, TT/AR takes place.

1.4.3.1 Write Command Functions (to Base).

Note: Many of the Write Commands are defined as being followed by one (or more) bytes of data. The device will execute the command following receipt of the data byte. If a second command is received instead of the data byte for the first command, the first command is lost and the second command sequence started. This operation applies to Base and Feature commands. Write type commands will remain active until reset by the next command (including Poll) except while busy. Refer to Clear command. Data

sent while no command stored will be lost. TT/AR will occur, except in response to data sent to a busy display.

00010 RESET

A 3274 will send data to displays and printers. A 3276 will send only RESET commands.

For Displays: The Reset command (whether followed by data or not) will cause a partial POR sequence in the display. Base and feature storage will not be cleared. The Mask Register will not be altered. The I/O Address Counter will be set to Hex '50' (Hex '40' in 3278 Mod I.) which corresponds to the first character location on the screen. The device will execute the TT/AR sequence. POR Response will be returned to a subsequent Poll.

For Printers: In a printer the Reset command will terminate any operation in process and cause the printer to respond to a Poll with the POR complete status code. The printer will then be able to accept and execute any valid command (i.e. the printer will be disabled.) The message buffer will not be cleared, and the control unit output area will be cleared. The Address Counter will be set to '0000', and the Mask and Control Register will be reset. The following portion of the Printer Output Area will be initialized:

Byte 0: All bits except 4 & 7 must be zero.
Byte 1: All bits valid.
Bytes 2 thru B: All zero.
Bytes C thru F: Terminal ID bytes initialized.

- To allow for control unit error recovery, the printer must appear enabled to the control unit immediately (within 20 usec) upon receiving the Reset command.

Note: Following Control Unit initialization of the printer (Read Term. ID, Load Address Counter, Read Data, etc.), the Control Unit must send 'Enable' Poll before sending a Start Op command to allow the printer to complete its' initialization. Also, the Control Unit will write a 4 character test message, X'AA 32 74 AA' or X'AA 32 76 AA', beginning at printer address X'004A', prior to sending the first enable poll. This sequence is required after all POR responses.

- Note: POR Complete will not be returned if the reset (either Command, Power On, or operator

initiated) 'failed', that is, if the printer has Equipment Check set in its status word.

The device must be capable of accepting two or more successive Reset commands (without intervening Poll commands) and respond with a single POR response to a subsequent Poll. Prior to returning POR response the device is allowed to terminate communication with the control unit.

10110 LOAD MASK

This command will cause the device to load the following data byte into the "Mask" register. The mask will be used in conjunction with subsequent Search and Clear commands. "1" bits in the mask will specify the bits in the buffer to be compared with the pattern byte. A mask of all "0" bits will prohibit a pattern test from being satisfied and cause the Clear command to terminate at address 0* and a Search Forward command to terminate at address 0 (or the first address encountered with bad parity.) (*For printers, low order Address Counter bits equivalent to installed buffer will be zero.)

For Displays: The Mask byte must be reloaded following an Insert Byte command.

For Printers: The Mask byte must be reloaded following a Start Print order.

00110 CLEAR

The Clear command clears all or part of the printer storage or regen. buffer in the addressed device to nulls. A byte of data, called the pattern byte, is transmitted following the Clear command. The device uses the pattern, in conjunction with the previously loaded mask, to terminate the clear function. The address counter is used to indicate the point at which the Clear function starts. All locations including the starting address up to but not including the location containing the byte that satisfies the pattern and mask are tested and cleared. Upon completion the address counter will be pointing to the satisfying location. The command will terminate at address 0 (without clearing address zero) if no match occurs (For printers: Low order Address Counter bits equivalent to installed buffer will be zero.)

This command may also be used to clear the storage area containing the indicator character codes or printer register space. The Clear operation will not terminate prematurely if a buffer parity error is detected. Device Check will be set (if not inhibited due to a previous parity error) if a parity error is detected. Upon completion of the command the Operation Complete bit (bit 9) will be set in the poll response status word. Prior to setting Op Complete the device will be busy. Poll response while busy will be the Auto Response (clear response). Commands other than Poll and Reset sent to a device while the base is busy will be no-op'd. TT/AR will occur, except following data, chained or unchained, sent after a Write type command to a display. Busy also applies to Search and Insert commands.

To prevent control unit timeout, the busy state of the device must not exceed 32 msec. To allow for control unit error recovery, the device must appear busy to the control unit immediately (within 20 usec) upon receiving the Clear Pattern byte, unless the operation is completed and OP complete is posted in the poll status.

The address counter must be set to within the Read buffer before issuing CLEAR, SEARCH or INSERT.

01100 WRITE DATA

The Write Data command will cause the device to accept all following data words for storage until another command is received. The data will be loaded at the location indicated by the address counter. The address counter will step up once for each data word received and stored. Codes for specific characters and attributes are defined in Section 4.0.

01010 LOAD CONTROL REGISTER

This command will cause the device to load the following Data Word into the Device Control Register (double line transfer.) The Control Register will be set to all zeros by POR and the Reset command, but otherwise not altered by the device. The Control Register bits are defined as follows:

Bit

2=1 Spare
3=1 Spare
4=1 Set 480 Character Format. This bit will be set b-

the control unit when the Application Program has specified that the 960 display is to be set to 480 mode.

5=1 Reserved

6=1 Inhibit Display. When this bit is set, the display screen, except for the cursor and indicator row, will be blanked.

7=1 Inhibit Cursor Display. When this bit is set, the cursor will not be displayed.

8=1 Reverse Image Cursor. This bit will cause the cursor to be displayed as a reversed image of the associated character box.

9=1 Blink Cursor. This bit will cause the cursor to blink.

8&9=0 Normal Cursor. The printer will no-op this command.

10100 LOAD ADDRESS COUNTER LOW

This command, followed by one data word, will load the 8 bits of the data word into the 8 low order bits of the address counter. This command will enable cursor display (at the screen location associated with the value in the address counter) if the cursor had previously been blanked due to a busy condition.

00100 LOAD ADDRESS COUNTER HIGH

This command, when followed by one data word, will load the data word into the high order bits of the address counter.

01000 START OPERATION

When this command is sent to a printer the printer will go enabled. Upon completion (or termination) of the operation (as specified in the 8 bit order register) the printer will return Status Available in Poll Response. Order Complete Status will be set. To prevent control unit timeout, the device must complete the operation, except for Print Order, within 500 milliseconds (excluding the duration of any intervening disable time). While the printer is enabled, the printer must treat as invalid any command other than Poll, Reset and Start operation (Abort Order). The printer will switch to the disabled state when Status Available is set.

To allow for control unit error recovery, the printer must appear enabled to the control unit immediately (within 20 usec) upon receiving the Start Op Command. Upon receiving the Start Op Command, the printer must test the Poll Response Register (bits 6,8,9,&10) for zero. If zero, the order will be executed; if non-zero, the printer must ignore the Start Operation command and remain disabled. TT/AR will occur.

This command will be no-oped (treated as spare) by the display.

01110 INSERT BYTE

This command will cause the display to accept the following data word and place it in the buffer storage at the location indicated by the current value of the address counter. The original contents of the storage location is shifted one location ahead. This sequence is continued for each successive location until a null character or attribute is found, or the I/O address counter steps to zero (in which case the character that formerly resided in the last addressable location of storage will be lost.) Only one data word may follow this command. During the time that shifting takes place, the display will be busy. Refer to Clear command. Op Complete is set when this command is completed. At this time the address counter is pointing to the last character moved unless the command terminated at an attribute, in which case the address counter will be pointing to the attribute and the character which was located ahead of the attribute will be permanently lost. The insert operation will not terminate prematurely if a buffer parity error is detected. Upon completion of this command the Mask register must be reloaded by the control unit prior to the next Search or Clear command.

This command will be no-op'd by the printer.

The address counter must be set to within the Read buffer before issuing CLEAR, SEARCH or INSERT.

10000 SEARCH FORWARD

This command, when followed by a "pattern" data byte, will cause the device to search each buffer storage location starting at the current value of the address counter until a byte that satisfies the mask and pattern is found. The address counter will contain the value of the address in storage of the first satisfying byte found. If no satisfying bytes are found, the Search command will terminate at address 0. (For printers: Low order Address Counter bits equivalent to installed buffer will be zero.) To allow for control unit error recovery, the device must appear busy to the control unit immediately (within 20 usec) upon receiving the Pattern Byte, unless the operation is completed and OP complete is posted in the poll status.

The address counter must be set to within the Read buffer before issuing CLEAR, SEARCH or INSERT.

10010 SEARCH BACKWARD

This command operates in a similar manner as the above Search command. If no satisfying bytes are found, the search will terminate one location past address zero (all address bits implemented set to 1.)

To allow for control unit error recovery, the device must appear busy to the control unit immediately (within 20 usec) upon receiving the Pattern Byte, unless the operation is completed and OP complete is posted in the poll status.

Note: The two Search commands will indicate completion of the operation by setting bit 9 in the status response word to a Poll command. While the search is in progress the display will be busy. Refer to Clear command. A buffer parity error detected during a search memory cycle will cause the search to terminate. The address counter will be pointing to the location containing the byte with bad parity. Op Complete (bit 9) will be set, and Device Check (bit 8) will be set if not inhibited due to a previous Device Check.

The address counter must be set to within the Read buffer before issuing CLEAR, SEARCH or INSERT.

1.4.4 Device Feature Commands (Bits 6, 7, 8, and 9)

For Displays:

The 'Feature Error' latch is set for the following conditions:

1. A feature does not acknowledge a Write type command or data.
2. A feature does not respond to a Read type command.
3. A feature requesting Poll service does not respond to this Poll

For case 1, the display will set bit 11 - 'Feature Error', but respond with TT/AR. For case 2, the display will respond with an 'all zeros' data word TT/AR? with bad parity (bit 10=0). (The 'all zeros' data word will actually contain the 9 bit byte from the feature and may be non-zero if the addressed feature, or one of the other features, is malfunctioning.) The feature error bit will be set. For case 3, Bit 11 returned in poll response.

1.4.4.1 A/N Keyboard Feature

The keyboard will only respond to a Poll.

1.4.4.2 Selector Pen Feature

C001 POLL (See status response.)

0011 READ ROW COUNT

Following a detect the selector pen will respond to this command with a row count (in bit positions 4 to 9) indicating the displayed row in which a detect occurred.

1111 READ SELECTOR PEN FIELD COUNT

Following a detect the response to this command is a count in bit positions 6 through 9 that indicates the Selector Pen field count at the time a detect occurred. (The field counter is reset to zero before the start of each row.) A Selector Pen field is a detectable attribute followed by a designator character.

Note: If either of the above two commands is issued after the Reset command but before a detect, a Feature Bus Timeout will occur.

01X1 READ FEATURE CONFIGURATION

Responds with feature address in bits 2 through 5 if feature is present.

0010 RESET

The Reset command will reset all latches and registers in the addressed device feature and must be sent to re-enable the selector pen for another detect.

1.4.4.3 Magnetic Stripe Reader Feature

C001 POLL (See status response.)

0011 READ DATA

The Read Data command is issued to the Magnetic Stripe Reader when the poll response word indicates that the Reader has data to send to the control unit. The first data word is sent in response to the first Read command and the (Read-Response) sequence continues until terminated by the control unit. The Magnetic Stripe buffer address counter will increment for each byte of data read from the buffer. The Magnetic Stripe Reader will determine when the last significant byte of data (EOM) has been read. EOM will be returned on

all subsequent Read Data and/or Read Multiple commands until a Reset or Clear command is received.

If a Read Data (or Read Multiple) command is issued after a Clear or Reset command but before a card is fed through the reader, a Feature error will occur.

1011 READ MULTIPLE

The feature will respond with four successive bytes of data. The same restrictionsas for Read Data apply

01X1 READ FEATURE CONFIGURATION

Responds with feature address in bits 2 through 5 if feature is present.

0010 RESET (RETRY)

The Reset command is sent following a control unit detected error during the previous Magnetic Stripe Read command. The feature is reenabled to the operator, hardware is reset, yellow and green lights extinguished, and the red light turned on.

0110 CLEAR

This command is normally sent to re-enable the feature to the operator. Hardware is reset, the yellow and red lights extinguished, and the green light turned on.

SECTION 2. PRINTER CONTROL

2.0 GENERAL

This section defines the additional control provided for printers by means of preassigned register space in the printer buffer in conjunction with a subset of the above described coax commands for reading and writing this buffer.

The commands recognized by the printer are:

READ		WRITE	
00001	Poll	10110	Load Mask
10001	Poll/Ack	00010	Reset
00011	Read data	01100	Write data
00101	Read Adr. Cntr. Hi	00100	Load Adr. Cntr. Hi
10101	" " " Lo	10100	" " " Lo
01001	Read Terminal Id	01000	Start Operation
01101	Read Status	00110	Clear
		10000	Search Forward
		10010	Search Backward

The operation of these commands is described in preceeding sections of this document. Other commands, including all commands to other than the base address, are invalid. Invalid read type commands will return an all zeros data word (with bad parity -Bit 10) and invalid Write type commands will (may) reset the previous command. If no other command or data word directly follows the invalid Write command, TT/AR take receipt of the ending sequence. Invalid commands include printer no-op commands. Commands other-than Poll, Reset and Start Operation (Abort Order) will be treated as invalid while the printer is enabled or busy.

2.1 PRINTER REGISTER SPACE

The first 80 bytes of the printer buffer are used as register space to store control information. The first sixteen bytes are used for printer output to the control unit. The next 64 bytes are used for control unit orders and instructions to the printer. Protocol prohibits the Control Unit and the Printer from altering each others' Output Area (except at POR time.) The assignment is:

ADDRESS (hex)	LENGTH (bytes)	DEFINITION
Printer Output Area		
0000	1	Status
0001	1	Switch Status
0002	1	Key Input Code
0003	1	Sense
0004-000B	8	Reserved
000C-000F	4	Terminal ID
Control Unit Output Area		
0010-0011	2	Mode
0012-0013	2	Message Starting Address
0014-0015	2	Message Length
0016-0017	2	Order
0018	1	Maximum Presentation Position (MPP)
0019-0049	49	Reserved
004A-004D	4	Test Message Area (Refer to Section 1.4.3.1)
004E-004F	2	Reserved for Control Unit use

Note: For the printer Register Space Bit definitions, Bits 0 - 7 correspond to Interface Data Word Bits 2 - 9.

2.2 PRINTER OUTPUT AREA

2.2.1 Status

The Status Bits are defined as follows:

Bit 0	Reserved
Bit 1	Data Check
Bit 2	Order complete
Bit 3	Equipment Check
Bit 4	Intervention Required
Bit 5	Sense Data Available
Bit 6	Input Code Available
Bit 7	Switch Transition (Valid)

- **Data Check**
  Bit 1 — Set, with Order Complete, when the printer detects a parity check in the message buffer (not Register Space) while printing. Reset when enabled.

- **Order Complete**
  Bit 2 — Set when the order, as specified in the two byte Order Register, has been completed or terminated. Reset when the printer is enabled.*

- **Equipment Check**
  Bit 3 — Set when a printer detects a 'Permanent Error' condition. Cleared by a successful POR. A permanent error results when the printer detects a parity error or invalid parameter in the control unit output area (Printer Register space). If invalid parameter, Status Bit 5 will also be set, and Sense code '04' - Order Reject' will be loaded.

Intervention Required
Bit 4 — Set, after a device determined delay, when an operator recoverable (without POR response) condition occurs. Reset when the above condition is removed.

Note: The control unit is not allowed to alter the printer print buffer or the Control Unit Output Area after receiving IR,OC status, until receiving IR cleared status.

Sense Data Available
Bit 5 — Set when new sense data is loaded into the sense byte and reset when the printer is enabled.*

Input Code Available
Bit 6 — Set when new input code is loaded into the input code byte and reset when the printer is enabled.*

Switch Transition
Bit 7 — Set when any valid transition of the applicable switches on the printer operator panel occurs and reset when the printer is enabled.* New status of the operator panel switches is stored in the switch status byte.

*(Provided Poll Response is all zero. Refer to Start Op command.)

The Status Available Bit (in Poll Response) is set when any of the above status bits are set or when Intervention Required is reset. Transition of two or more status bits may occur for one Status Available Poll Response.

Defined combinations of status bits are:

Status Bits	Occurance
2	Print, SSA or Abort Order with Print Order successfully completed.
1,2	Data Check while printing. Print completes.
2,3	Printer Register Space Check following Start Op Command.
4	IR condition while idle.
3	EC condition while idle.
2,4	Print Order terminated due to IR condition.
2,5	Print Order terminated due to Sense condition.
2	Print Order terminated by an Abort Order.
2,3	Print Order terminated due to Equipment Check.
2,3,5	Print Order terminated due to invalid parameter in Control Unit Output Area.

Multiple failures or other undefined error conditions may result in other combinations of Status Bits being generated.

The print operation in process will be terminated whenever Equipment Check, Intervention Required, or Sense Data Available are set.

2.2.2 Switch Status

This byte contains the current status of certain operator panel switch positions. Whenever positions of APL/KATAKANA, MONO/DUAL Case, SINGLE/DOUBLE INDEX and 8/6 LPI switches are altered by an operator the Status Bit 7 (Switch transition) is set and new switch status is loaded into this byte.

Bit 0 thru 4=Reserved

Bit 5=1= MONO/DUAL SW in DUAL position
=0= MONO/DUAL SW in MONO position

Bit 6=1= SINGLE/DOUBLE SW in DOUBLE position
=0= SINGLE/DOUBLE SW in SINGLE position

Bit 7=1=8/6 SW in 8 LPI position
=0= 8/6 SW in 6 LPI position

2.2.3 Input Code

This byte will be loaded by the printer when a switch that initiates host and/or control unit intervention is actuated or timeout/no PA's installed condition occurs. The following four input codes are defined for the printer:

X'50' = Attention
X'5F' = PA 1
X'5E' = PA 2
X'5D' = No PA Keys Available/Actuated

Attn is allowable only in Printer SLU Receive state. Attn does not terminate the order in process or alter the printer SLU (Secondary Logical Unit) send/receive state.

PA1, PA2, and No PA are allowable only in printer SLU send state. Printer SLU will assume receive state upon disabling and returning the Input Code. No PA code may be sent after timeout in send state.

2.2.4 Sense Data

This byte will be loaded by the printer when the printer has sense data to be sent to a host via a control unit.

:en this byte is available, status bit 5 will also be
:t.

X'01' Cancel

This code indicates that the Cancel key is depressed by an operator in order to cancel printing. The printer will immediately terminate printing in process. The Cancel key is only active between First Segment of First in Chain and Last Segment of Last in Chain. If a Print Order is in process the printer will return Cancel and Order Complete. If a print order is not in process, the printer will wait for the next Start Print and: If FSFIC, ignore the Cancel; If not FSFIC, abort the print and return Cancel and Order Complete. Controller is responsible for purging remainder of the chain after receiving CANCEL. The next SCS START Print sent to the printer will be FSFIC.

X'02' Invalid Parameter

This code indicates that an invalid control parameter is found in the SNA character stream by the printer.

X'03' Reserved

X'04' Order Reject

Set when printer detects an invalid order or parameter in the Control Unit Output Area. Status bits 2,3 (and 5) will be set.

:.2.5 Printer ID

:his byte, loaded by the printer, contains the unique :evice parameters that are significant to the control :nit and/or the application program. Definition of this :yte is as follows:

Byte 0

Bit 0,1, and 2= Reserved

Bit 3=1= LU1 EBCDIC feature installed
=0= Not installed

Bit 4,5 and 6 Logical buffer size:
001= 960
010= 1920
011= 2560
111= 3440

Bit 7=1= Printer (Unit ID)
=0= Other (Unit ID)

Byte 1 Buffer Size

X'08'= 2048 Buffer
X'10'= 4096 Buffer

Byte 1 will be set to the equivalent value of the high order byte when the size of the printer buffer installed (plus 1) is counted in 2 byte binary format.

Byte 2 Reserved

Byte 3 Reserved

2.3 CONTROL UNIT OUTPUT AREA

2.3.1 Mode (2 bytes)

The mode bytes define in which data stream mode the Subsystem is operating. The mode remains in effect until overlayed with a new mode. The modes are defined as follows:

LU2/3 Mode - The 3270 Data Stream is supported under SNA. (See Section 4.1).

3270 Mode - This mode allows usage of the 3270 Data Stream over BSC and 3272 local channel attachment. (See Section 4.1).

SNA Character String (LU1) - This mode allows use of the LU1 data stream. (See Section 4.1.1).

Byte 0= Reserved

Byte 1= Bits 0, 1 & 2 = Reserved

Bits 3 and 4
00=Host Direct Print
01=Host Initiated Local Copy (including BSC Copy command)
10=Operator Initiated Local Copy

Bits 5 thru 7
000= No Mode (Refer to Section 2.3.3 for use of this code)

001=3270 Mode (Control Unit Output Area from X'0010' to X'0018' used)*
101=LU3 Mode (Control Unit Output Area from X'0010' to X'0018' used)*
110=LU1 Mode (Control Unit Output Area from X'0010' to X'0017' used)

* The data stream for these two modes appears the same to the printer.

The validity of the control unit output area and implemented functions vary among modes. The dependencies are summarized below:

Cancel Key - Active only in LU1 Mode (see last note under Print Parameter).

Program Attention Keys (PA 1& 2) - Active only in LU1 Mode.

X Print Function - Active in LU3 and 3270 Modes only.

2.3.2 MSA and ML

The Message Starting Address Bytes specify the buffer address where the message buffer starts from and the message Length Bytes specify the size of the message buffer to be operated on by the printer. In LU1 Mode print data will wrap from the end of the implemented buffer to address X'0050'.

If ML = zero for Start Print order, the printer will suppress any printing and return order complete.

2.3.3 Order

Two bytes are used as the order bytes to specify what operations will be performed by the printer. The first byte contains an order and its parameters are specified in the second byte if applicable. Order complete status will be set upon completion of the operation. The order will remain loaded until overwritten by the next order. The order will be examined and executed following a Start Op Command, providing there is no pending Poll Response Status. Refer to Start Op Command.

The printer must test the mode byte prior to executing the order. The following mode changes have unique significance:

any --> No Mode: PA & Cancel keys deactivated, printer SLU enters or remains in receive state. LU1 parameters loaded by SHF, SVF, or SLD will be retained for the next LU1 Start Print. Any pending PA input will be reset. Unique conditions associated with the previous mode will be reset.

LU1 --> LU3,3270,: Previous LU1 parameters saved, PA saved.

any --> LU1: Previous LU1 parameters, if any, restored.

Byte 0 X'01'=Abort
X'02'=System Status Available
X'03'=Print

Byte 1 Parameters for Orders

Abort ('01')

This order causes the printer to terminate the print order in process. No parameters are available for this order. Following receipt of this order the device must respond with one, and only one, Order Complete. The printer will ignore an abort order (and remain enabled) if no print operation is in process. The control unit may only send this order following a 'Start Print' Start Operation and prior to receiving Order Complete. The control unit may not change the Mode when sending this order.

System Status Available ('02')

X'00' May be used by control unit to indicate Mode change.

X'02' Indicates that the printer SLU enters the send state.

X'03' Indicates that the printer SLU enters the receive state.

Note: Outstanding PA indication will be cleared whenever the printer SLU returns to receive state.

Note: '02' and '03' will only be sent in LU 1 mode.

Print ('03')

Printing of the message buffer specified by the MSA and ML will be performed by the printer. Refer to 4.1.1 for code points. 3270 like print function will take place in any modes other than the LU1 & No Modes.

In the LU1 Mode the message buffer contains both control characters (with or without their parameters) and graphic characters. The printer will access I/O codes from the beginning of the message buffer to the end of the message buffer sequencially. A character will be printed if it is a graphic character and the control function will be performed if the control character is supported.

If No Mode is specified, printer will suppress any printing. Order complete will be returned.

The following parameters are defined for the print order:

Bit 0=1 Reserved
0=0 Reserved

Bit 1=1 First Segment of First in Chain

Bit 2=1 Last Segment of Last in Chain

Bit 3= Reserved

Bit 4= Reserved

Bit 5 & 6 Dual/Monocase
00= Machine Default as configured
01= Monocase
10= Dualcase

Bit 7*=1= Ignore NL, EM and CR and print space for them
=0= Honor NL, EM and CR (3270 non line length format)

* Note: MPP does not effect honor of NL, EM and CR. Honor is only defined by Bit 7. FF is honored regardless of Bit 7 setting, but only when it is encountered at the left margin print position. When FF is not honored, a space is printed.

Note: Bits 1 and 2 valid in LU1 mode only. Bits 5,6 & 7 valid in non-LU1 modes only.

Note: Bits 1 & 2 are used to control the operation of the Cancel Key. Cancel is allowed, in LU1 mode, from Start Print of first segment of First in Chain until Order Complete on last segment of Last in Chain. Also, the controller must set bits 5 and 6 to 1Ø (Dualcase) for SCS.

1.3.4 Maximum Presentation Position (MPP)

The MPP specifies the maximum print position per line. If zero, print full width as determined by hardware. The MPP byte is loaded by the control unit in all modes except LU1 Mode.

1.4 PRINTER RECOVERY AND OPERATOR PANEL

While idle, and Enabled (with no Equipment Check pending), the printer will run a timer and periodically (10-60 sec.) disable and return 'status available' (bit 6 Poll Response). The control unit will read the status register, compare the contents with the previously returned status, and re-enable the printer. The printer will indicate 'subsystem not ready' whenever disable lasts longer than 7 seconds. 'Subsystem not ready' indication will be turned off when the printer is again enabled.

SECTION 3. CONTROL UNIT TO DEVICE INTERFACE

3.0 GENERAL

The Control Unit to Device Interface is a single wire coaxial cable (coax) interface using type RG62AU coaxial cable with serial by bit data transferred in either direction but in only one direction at a time. The control unit operates as a master, and the attached device operates as a slave. Each device attached directly to the control unit receives and sends data addressed only to that device.

Bits on the coax appear as positive and negative going pulses. Binary data is phase encoded such that a 212 nanosecond (ns) up-level. followed by a 212 ns down-level, represents a binary 0. Similarly, a 212 ns down-level, followed by a 212 ns up-level, represents a binary 1. A predistortion pulse is generated for every transition from an up-level to a down-level or vice versa. (See waveforms in 3.0 (A) and 3.0 (B).)

The waveforms shown in 3.0 (A) and 3.0 (B) are the signals measured across the coax at the transmitting unit (either control unit or device).

The waveforms shown in 3.0 (C) and 3.0 (D) show the signal across the coax at the receiving end of 5000 feet (1,524 metres) of coax.

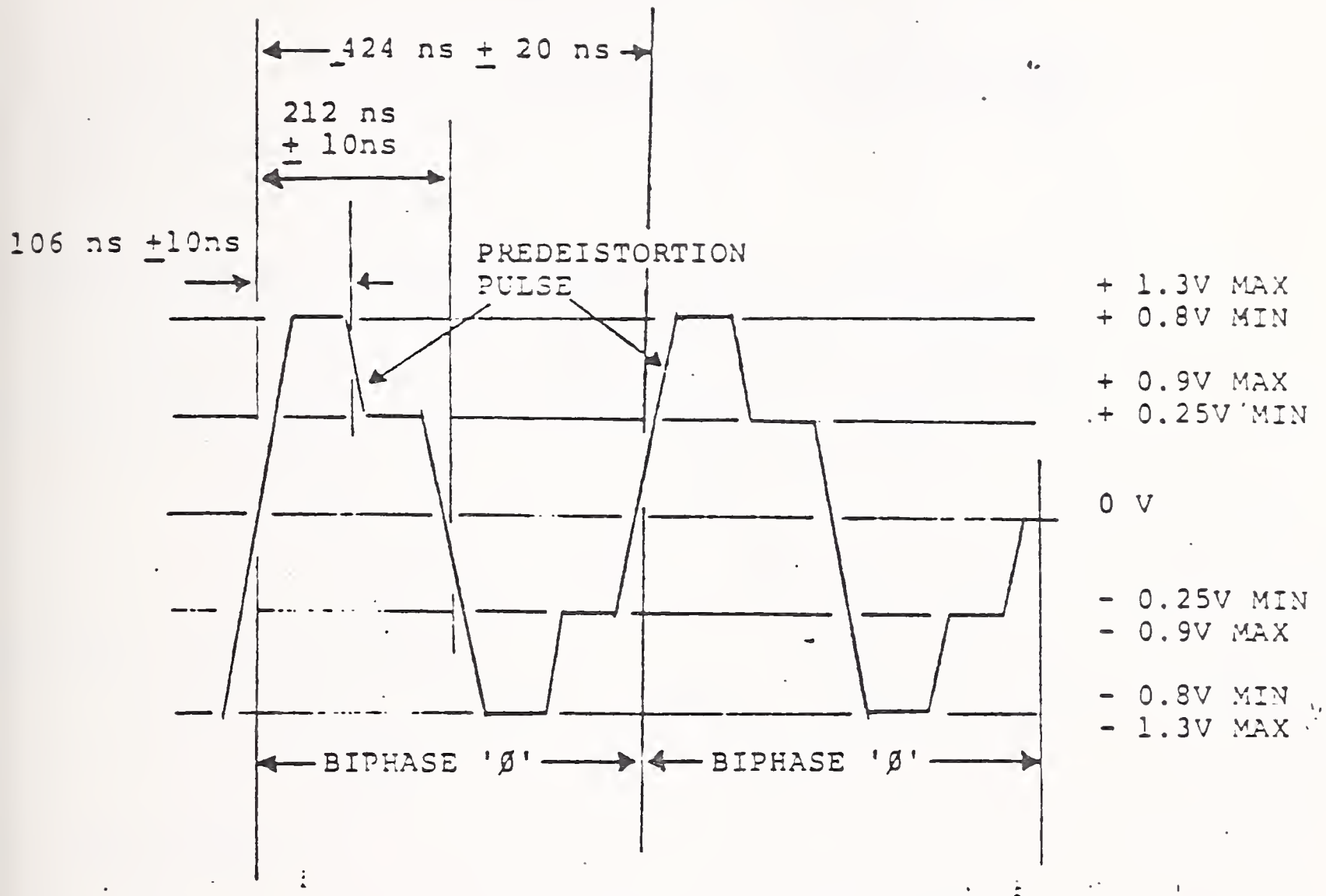


Figure 3.0 (A)

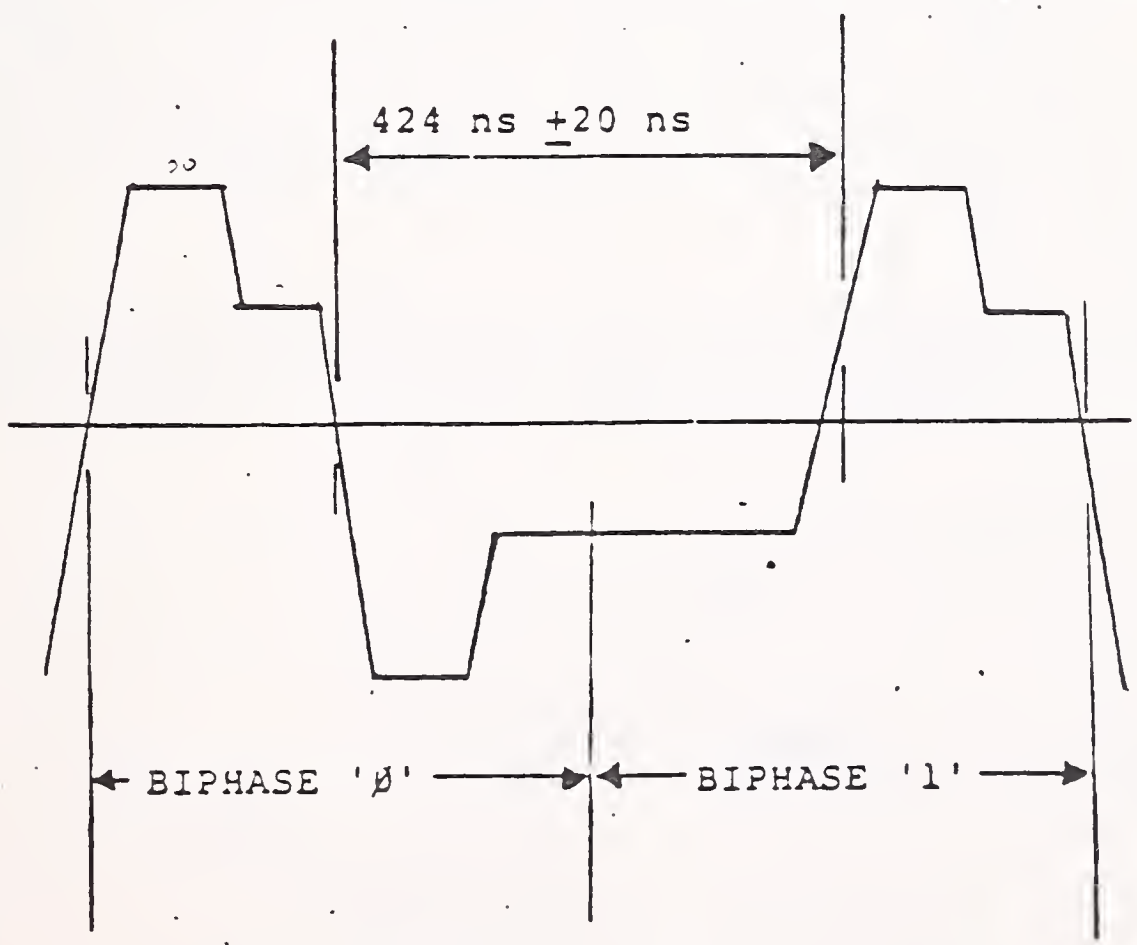


Figure 3.0 (B)

ALL RISE AND FALL TIMES 30 ns MAX.
RISE AND FALL TIMES ARE EXAGGERATED FOR CLARITY.

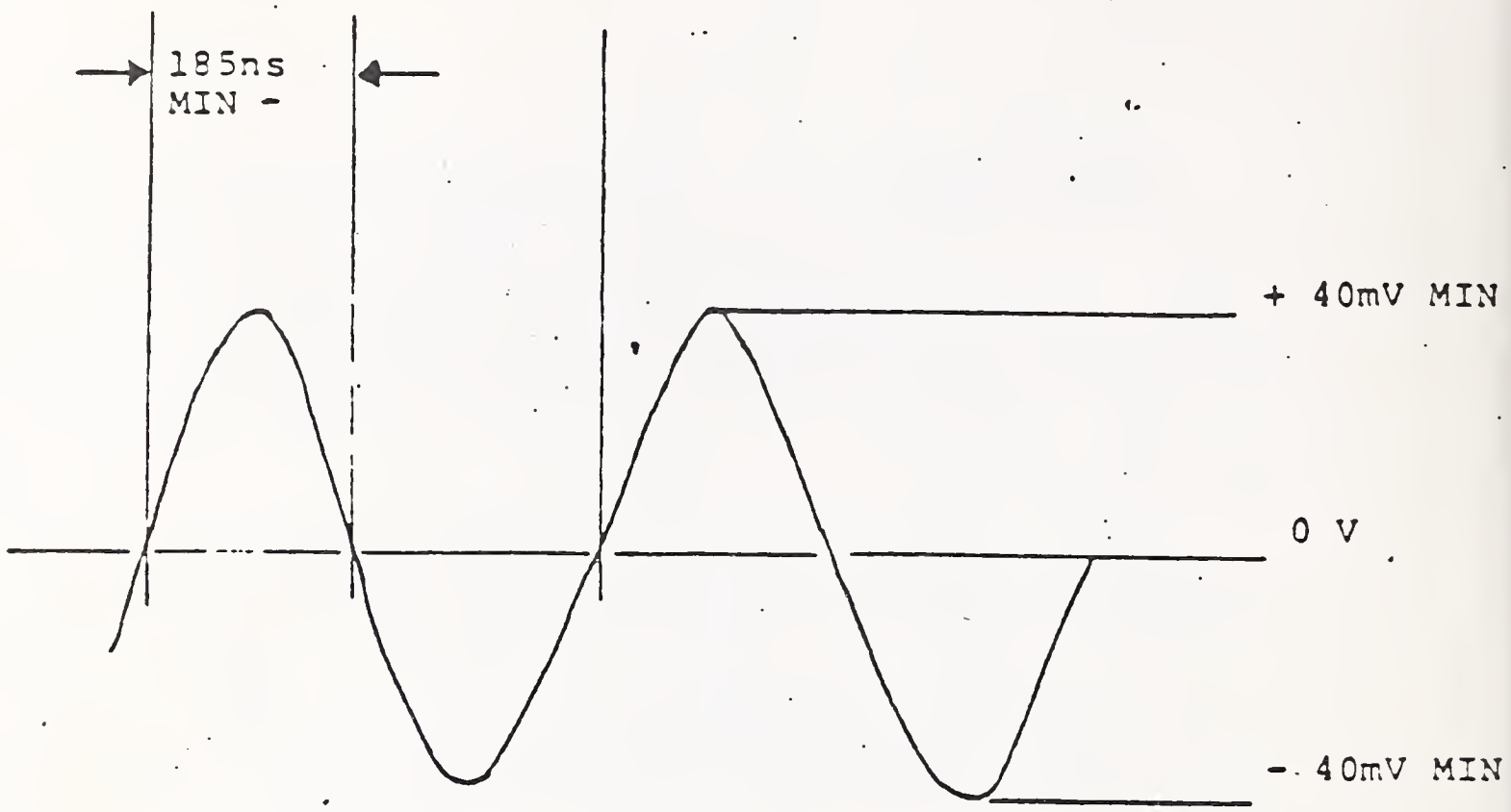


Figure 3.0 (C)

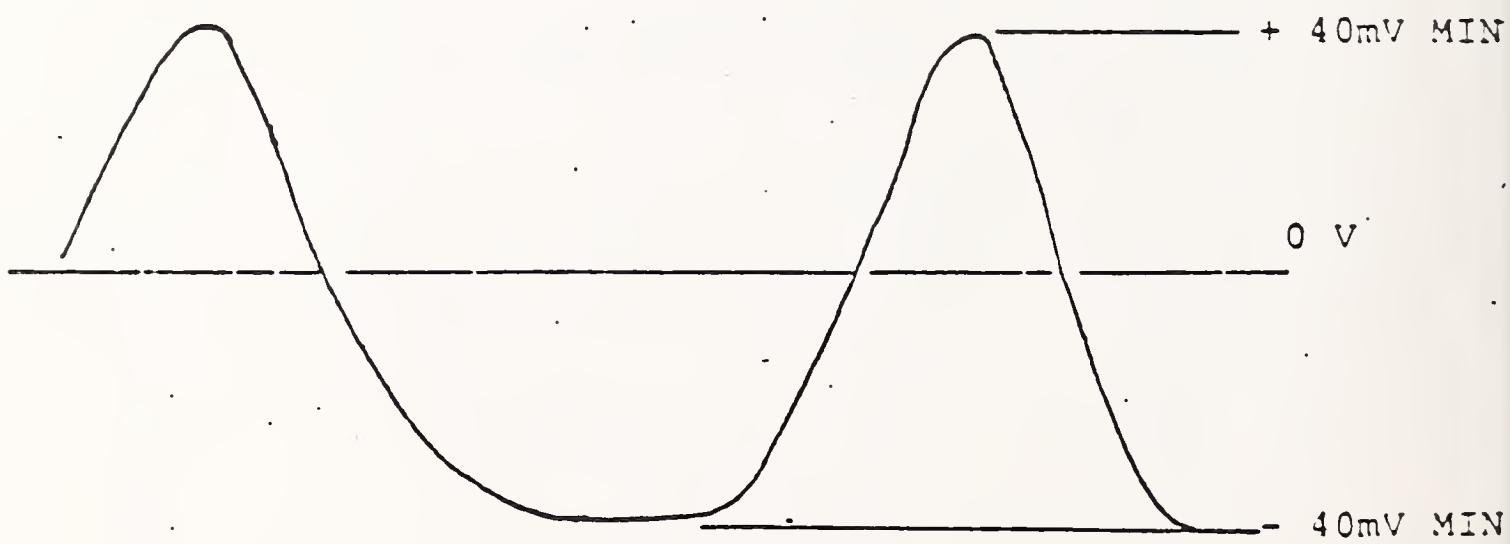


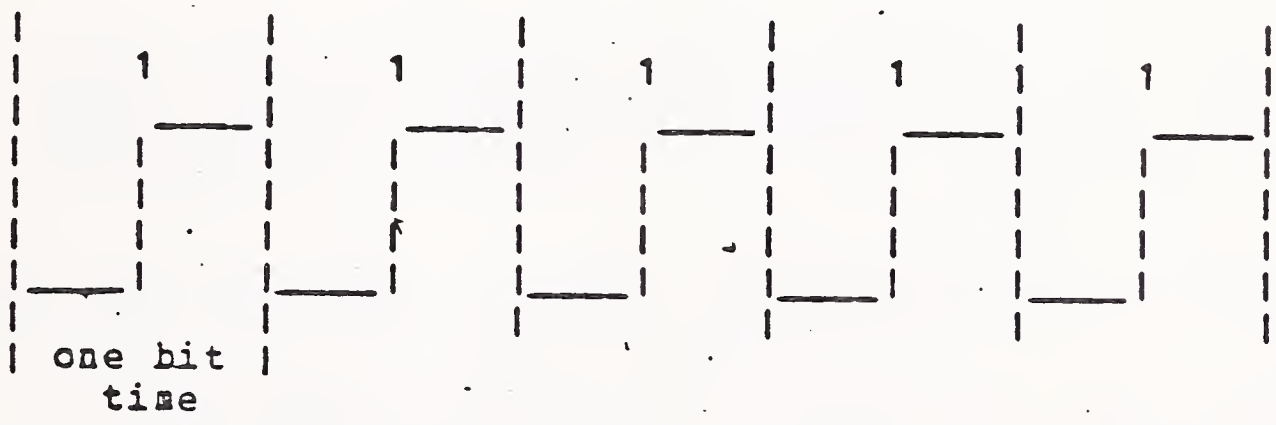
Figure 3.0 (D)

3.1 COAX TRANSMISSION PROTOCOL

The dipulse technique is utilized to provide a voltage transition of the coax at mid-bit time. Prior to valid data being transmitted, the coax must be conditioned to ensure that bit and byte synchronization may be achieved. This requires the transmission of a line quiesce and code violation pattern.

3.2 LINE QUIESCE PATTERN

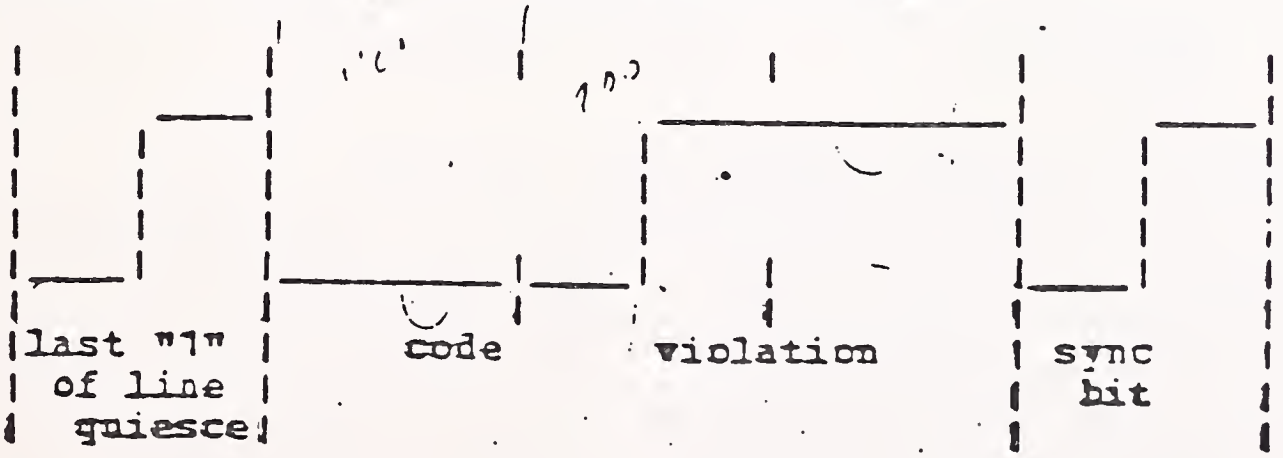
It is necessary to establish an equilibrium switching condition on the line after the null condition of line turn around before valid data can be properly detected at the receiver. Each data sequence from either control unit or device after line turn around will therefore be preceded with the following 5 bit biphase encoded data.



3.3 CODE VIOLATION

A code violation will follow the line quiesce pattern to differentiate between the quiesce pattern and the start of the valid data following the code violation. This is necessary because, due to varying line lengths, it is not possible to predict when the received data will become valid. However the code violation will be received properly thus providing a reference mark for start of transmission.

A unique balanced code violation sequence containing leading and trailing buffer bits to eliminate history dependence on adjacent data would appear as follows:

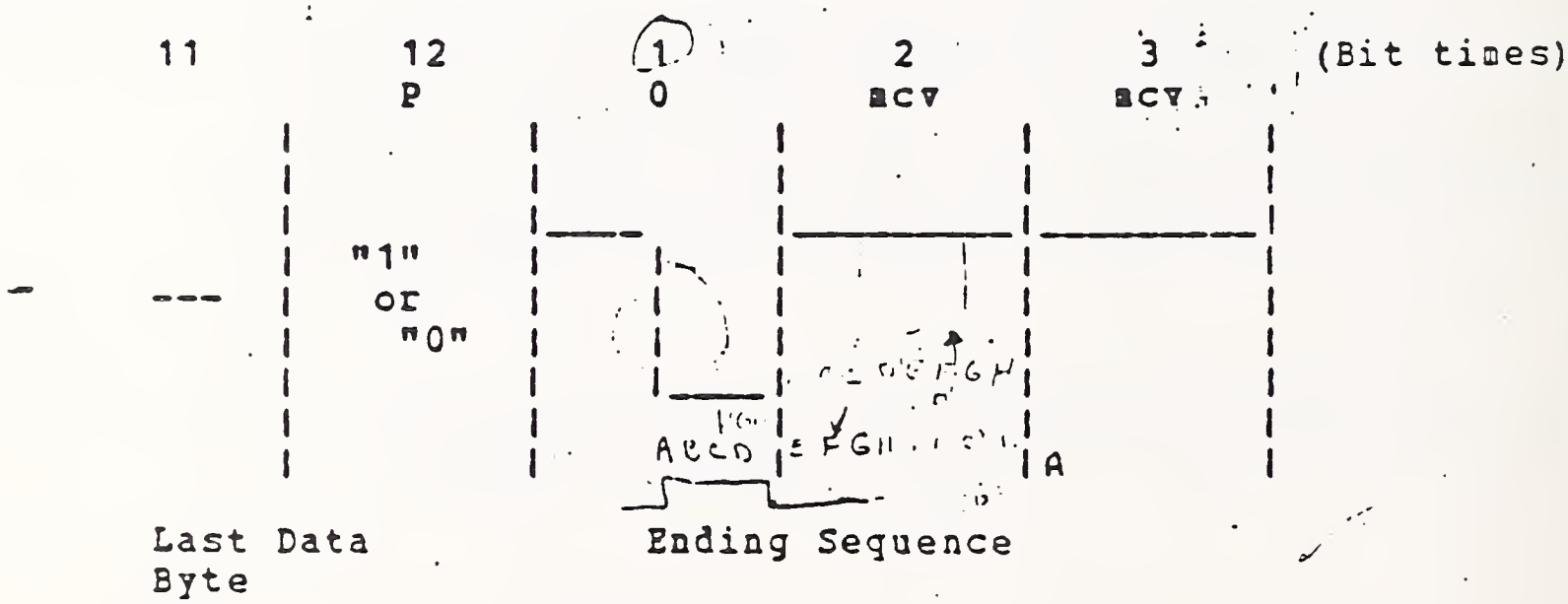


The trailing buffer bit is actually the sync bit of the following data byte. This code violation is unique in that it contains pulse widths (1 1/2 bit pulse widths) not present in normal biphase data (1/2 or 1 bit pulse widths) shown here for comparison.

Note that each bit has mid-bit transition. Thus, once decoded, this code violation provides, in addition to a reference mark for start of transmission, a definition of bit boundaries.

3.4 TRANSMISSION TERMINATION SEQUENCE (MINI-CODE VIOLATION - MCV)

In order that the receiver demodulation logic is reset at the end of a transmission, so that a subsequent transmission may be properly demodulated, a special termination sequence is used:



The last byte of data transmitted shall have 12 bits followed by a three bit Ending Sequence. The preceding 12 bit word is as previously defined (starting with sync and ending with a parity bit). The first bit of the Ending Sequence shall be a zero followed by two bit times without a mid-bit transition. (These are referred to as minicode violations.) The first minicode violation is always used to reset the receiver logic. The second merely guarantees that the line does not discharge and generate a spurious clock pulse while the logic is detecting the first MCV. The zero in the first bit

position allows for discrimiating a Transmit Check condition generated as a result of invalidly padded zero bits between bytes from a normal ending sequence.

3.5 TRANSMIT CHECK

A Transmit Check is defined as follows:

1. A 0 in the sync bit location not followed by the mini code violation.

2. The loss of mid bit transition detected at other than normal ending sequence time.

3. A transmission parity error (bit 12 not being even.)

When a Transmit Check is sensed in the device, the device will cease accepting data and all commands and suppress the TT/AR. The stored command, if any, will not be reset. Normal operations will resume upon receipt of the next Line Quiesce/Code Violation.

The control unit will also test the same three conditions and provide for error recovery. Control units that only implement 1 byte Read commands need not perform the complete ending sequence test (Item 1 above.)

SECTION 4. CODE POINTS

4.0 GENERAL

The code points described in this section are transmitted over the coax.

4.1 DEVICE BUFFER CODES

4.1.1 Character Codes

The following character codes are sent to display regeneration buffers and to printer "print" buffers. In addition to "internal code" (see following tables), EBCDIC LC1 will be sent to printers (see Character Set Reference Manual.)

4.1.1.1 Device Buffer Coding

	1 (00:XX)				2 (01XX)				3 (10:XX)				4 (11:XX)			
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SP	0	&	à	à	À	À	a	q	A	Q		P		
1	EM	=	1	-	è	è	È	È	b	r	B	R		S		
2	FF	'	2	.	ì	ì	Ì	Ì	c	s	C	S		A		Z
3	NL	"	3	,	ò	o	Ò	O	d	t	D	T				
4	STP	/	4	:	ù	u	Ù	U	e	u	E	U		B		!
5	CR	\	5	+	ã	â	Ã	Â	f	v	F	V		6		
6			6	¬	õ	ê	Õ	Ê	g	w	G	W				X
7			7	_	ỳ	î	Y	Î	h	x	H	X				
8	>	?	8	°	à	ô	A	Ô	i	y	I	Y		→		←
9	<	!	9		è	û	E	Û	j	z	J	Z				
A	[	$	£	^	é	á	E	Á	k	œ	K	Æ				0-
B	]	¢	§	~	ì	é	I	É	l	ø	L	Ø				
C	)	£	#	¨	ò	í	O	Í	m	ª	M	Å		B		4
D	←	¥	@	\	ù	ó	U	Ó	n	ç	N	Ç				A
E	}	Pts	§	/	ü	ú	Y	Ú	o	¯	O	;		?		
F	{	¤	_	ß	ç	ñ	C	Ñ	p	*	P	*				

MONOCASE FOLD

ADDRESS FOR CHARACTER GENERATOR

INDICATORS AND ATTRIBUTES

Notes:

(1) Characters in locations 00 thru 07 display as blank.
(2) Codes Hex 9E and 9F are the FM and DUP characters.
(3) Lower case characters in columns 4 & 5 and 8 & 9 fold to upper case characters, columns 6 & 7 and A & B, when the Display is in the Monocase Mode.
(4) Printers are required to support only those graphics that are defined as valid for that particular language.

4.1.1.2 Device Buffer Coding for Katakana (and Japan English)

	1 (00XX)				2 (01XX)				3 (10XX)				4 (11XX)			
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SP	0	&	81	92	A6	C2		a	q	A	Q			
1	CM	=	1	¯	82	93	A7	C3		b	r	B	R			
2	FF	'	2	.	83	94	A8	C4		c	s	C	S			
3	HL	"	3	,	84	95	A9	C5		d	t	D	T			
4	STP	/	4	:	85	96	AA	C6		e	u	E	U			
5	CR		5	+	86	97	AC	C7		f	v	F	V			
6			6	¬	87	98	AD	CE		g	w	G	W			
7			7	−	88	99	AE	C9		h	x	H	X			
8	>	?	8		89	9A	AF	D1		i	y	I	Y			
9	<	!	9		8A	9D	BA	D2		j	z	J	Z			
A		$			8C	9E	BB	D3		k		K				
B					8D	9F	BC	D4		l		L				
C	)	£	#		8E	A2	BD	D5		m		M				
D	(	¥	@	^	8F	A3	BE	D6		n		N				
E	}		%		90	A4	BF	D8		o	~	O	;			
F	{		_		91	A5	C1	DE		p	÷	P	*			

SAME AS

SAME AS

* EBCDIC CODE * — FOR KATAKANA — ADDRESS FOR CHARACTER GENERATOR * INDICATORS AND ATTRIBUTES *

NOTES: (1) Characters in location 00 thru 07 display as blank.
(2) Codes Hex 9E and 9F are the FF and HL characters.

4.1.2 Attribute Codes

An attribute is used to specify the characteristics of the "field" (characters) that follows in the buffer. Each attribute occupies a location in the print buffer and displays (prints) as a blank.

DATA WORD BITS:

2	3	4	5	6	7	8	9	10
1	1	X	X	X	X	X	X	P

Bit 4=0 Unprotected
=1 Protected

Bit 5=0 Alphameric
=1 Numeric

Bits 4&5=11 Auto skip

Bit 6&7=00 Normal display, nondetectable
=01 " " detectable
=10 Bright " "
=11 Non " nondetectable, nonprint

Bit 8 Reserved. Used only by control unit.

Bit 9 Modified Data Tag (MDT).

4.2 MAGNETIC STRIPE CARD CODES

The following magnetic stripe card codes will be honored by the Magnetic Stripe Reader feature and stored by the feature for transmission to the control unit.

Magnetic Stripe characters are transmitted as follows:

5 Bit Card Code	P3210	P3210
	(1)	(2)
Coax Data Word	2345	6789 P

4.2.1 Magnetic Stripe Card Code-1, 10 Character (Numeric Only)

CHARACTER	HEX	BIT P3210	REMARKS
0	0	10000	
1	1	00001	
2	2	00010	
3	3	10011	
4	4	00100	
5	5	10101	
6	6	10110	
7	7	00111	
8	8	01000	
9	9	11001	
SPECIAL	A	11010	TRANSLATED, BY CONTROL UNIT, TO EBCDIC '7A
SPECIAL	B	01011	START SENTINEL (SS/RSS).
-------	C	11100	INVALID CHARACTER.
SPECIAL	D	01101	FIELD SEPARATOR.
-------	E	01110	INVALID CHARACTER.
SPECIAL	F	11111	END SENTINAL (ES).

4.5 Keyboard Scan Codes

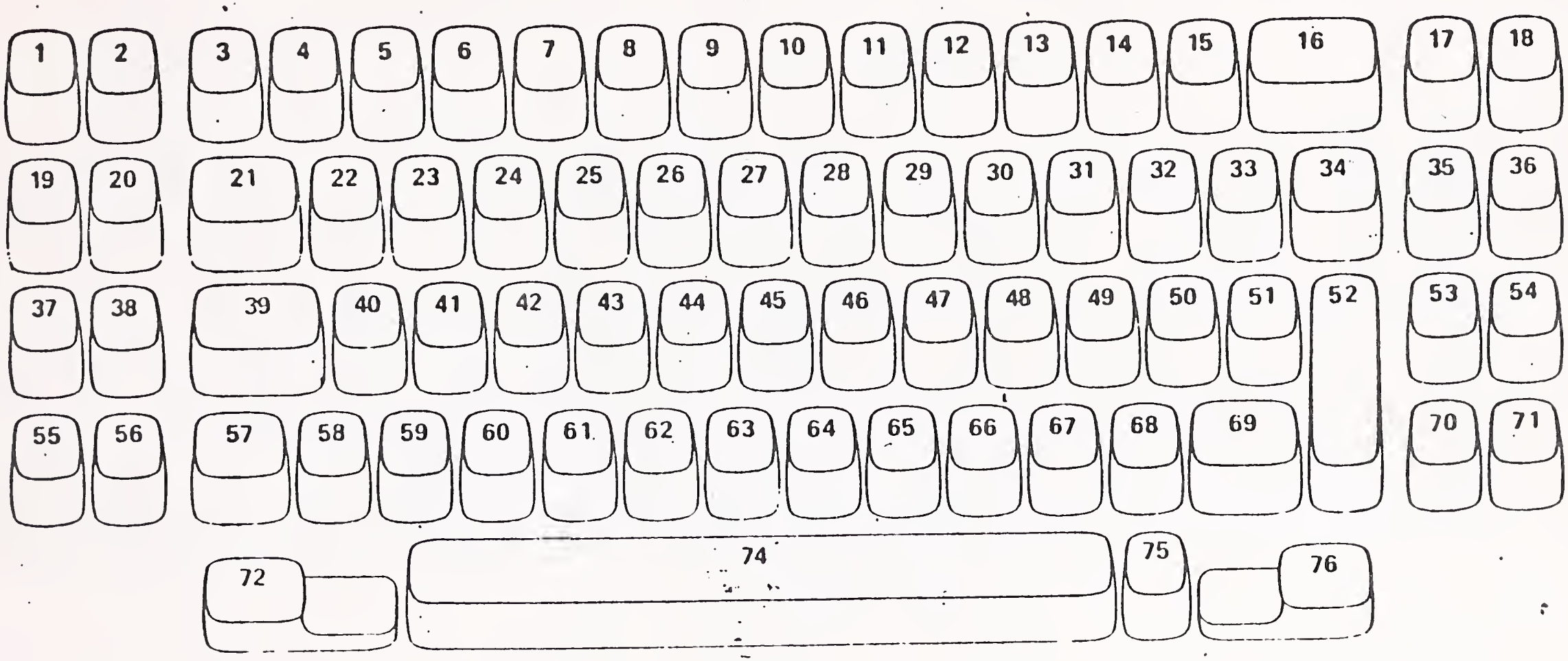
The following table lists the Scan Codes that are generated by all alphanumeric keyboards (including Katakana) that have 88, or fewer, keys. The keys that generate both make and break codes are shown with an 'X' in scan code bit 2, the make/break bit. This bit is a zero on make, one on break on the coax.

4.4 Keyboard Layouts

The following charts show the key number assignments for the 75 and 87 key alphanumeric keyboards. The 76 and 88 key typewriter keyboards are identical except for one additional key, number 51A, located on the third row between keys 51 and 52.

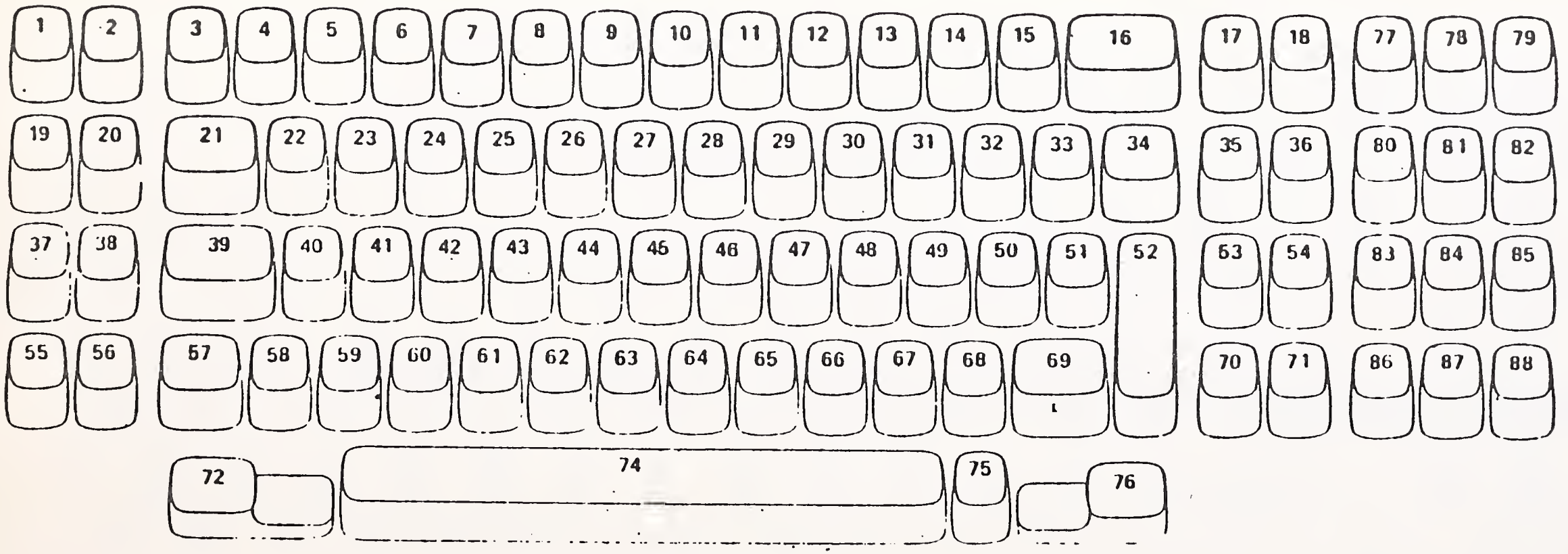
Key # (Coax bit position):	Hex	Scan Code 2345 6789
1	50	0101 0000
2	51	0101 0001
3	3D	0011 1101
4	21	0010 0001
5	22	0010 0010
6	23	0010 0011
7	24	0010 0100
8	25	0010 0101
9	26	0010 0110
10	27	0010 0111
11	28	0010 1000
12	29	0010 1001
13	20	0010 0000
14	30	0011 0000
15	11	0001 0001
16	31	0011 0001
17	5P	0101 1111
18	5E	0101 1110
19	52	0101 0010
20	53	0101 0011
21	36	0011 0110
22	70	0111 0000
23	76	0111 0110
24	64	0110 0100
25	71	0111 0001
26	73	0111 0011
27	78	0111 1000
28	74	0111 0100
29	68	0110 1000
30	6E	0110 1110
31	6P	0110 1111
32	1B	0001 1011
33	15	0001 0101
34	35	0011 0101
35	0C	0000 1100
36	0D	0000 1101
37	54	0101 0100
38	55	0101 0101
39	4C	X100 1100
40	60	0110 0000
41	72	0111 0010
42	63	0110 0011
43	65	0110 0101
44	66	0110 0110
45	67	0110 0111
46	69	0110 1001
47	6A	0110 1010
48	6B	0110 1011
49	7E	0111 1110
50	12	0001 0010
51	0P	0000 1111
51A	1D	0001 1101
52	08	0000 1000
53	0E	0000 1110
54	13	0001 0011
55	56	0101 0110
56	57	0101 0111
57	4D	X100 1101
58	09	0000 1001
59	79	0111 1001
60	77	0111 0111
61	62	0110 0010
62	75	0111 0101
63	61	0110 0001
64	6D	0110 1101
65	6C	0110 1100
66	33	0011 0011
67	32	0011 0010
68	14	0001 0100
69	4E	X100 1110
70	16	0001 0110
71	1A	0001 1010
72	34	0011 0100
73	NOT USED	
74	10	0001 0000
75	4F	X100 1111
76	18	0001 1000
77	40	0100 0000
78	41	0100 0001
79	42	0100 0010
80	43	0100 0011
81	44	0100 0100
82	45	0100 0101
83	46	0100 0110
84	47	0100 0111
85	48	0100 1000
86	49	0100 1001
87	4A	0100 1010
88	4B	0100 1011

00 → 00
01 → 10
10 → 10
11 → 10



Key 51A For Katakana Only.

Located between keys 51 and 52.



Key 51A For Katakana Only.

Located between keys 51 and 52.

APPENDIX B: QUESTIONNAIRES

- Vendor Interviews were completed with the following companies:
  - Courier Terminal Systems, Inc. (Division of ITT).
  - Computer Optics, Inc.
  - Genesis/Word Stream, Inc.
  - Raytheon, Inc.
  - Sycor, Inc.
  - Trivex, Inc.
  - Olivetti U.S.A., Inc.
  - Telex (TCI), Inc.

END USER SURVEY (10)

1. What type of IBM 3270 terminals and number of units do you have currently installed:

TYPE	# UNITS	IBM	OTHER MFG.
3277/75			
3278/76			

2. If other than IBM units, who is the vendor and approximate number of units installed?

VENDOR(S)	#UNITS

3. What type of terminals and number of units do you have on order from vendors during the next 9 months?

VENDOR(S)	TYPE	# UNITS

4. What is your estimate of your CRT terminal needs during 1980 to 1982 by vendor, terminal type and units?

	VENDOR	TYPE	# UNITS
1980			
1981			
1982			

5. What do you consider to be the four most important factors which influence your selection of a vendor? (in order of importance)

1. _____
2. _____
3. _____
4. _____

6. Name three reasons why you would change vendors?

   1. _____

   2. _____

   3. _____

7. a) Have you either changed or mixed CRT vendors in the past 2 years?
   NO☐ YES☐

   b) If yes, from what vendor _____

   to which _____vendor?

8. a) Would you select different vendors for specific products within your CRT network? NO☐ YES☐

   b) If no, why? _____

   _____

   _____

9. a) Have you experimented with SNA? ☐YES NO☐

   b) If yes, what % of your terminals are currently on SDLC lines _____%.

   c) What % of your applications are on SNA _____%.

   d) What are the two major applications?

      i. _____

      ii. _____

   e) Are you converting existing applications or adding new applications by %?

      i. Converting _____%.

      ii. Adding _____%.

   f) Have you experimented with "packet network?" YES☐ NO☐

      i. If yes, have you converted any applications? YES☐ NO☐

      ii. If yes, what are the 2 key applications?

         (a) _____

         (b) _____

      iii. Are you using a commercial or private network?
      Commercial☐ Private☐

10. What are your future communications network plans and what year do you propose to implement your network?

NETWORK TYPE	YEAR
_____	_____
_____	_____
_____	_____

11. What are the three most important reasons for changing your Communications network? (in order of importance)

1. _____

2. _____

3. _____

12. Please rank the following in importance for future planning: (5=high, 1=low)

Communications networks _____

Terminal Equipment _____

Software including conversion _____

Your CPU's _____

13. Will you require special terminals or software for specific applications?

NO ☐ YES ☐

14. a) Do you plan to go to distributed processing? YES ☐ NO ☐

b) Give three reasons for your decision.

i. _____

ii. _____

iii. _____

15. a) Do you consider the IBM 8100 system a product for your company to use? YES ☐ NO ☐

b) If yes, give two reasons why

i. _____

ii. _____

c) Also, if yes, have you planned to use the 8775 display rather than the 3277 or 3276/78? YES ☐ NO ☐

i. Why? _____

_____

_____

d) In your opinion, does the 8100 System provide or offer any unique competitive advantages? YES ☐ NO ☐

i. If yes, name the two most important advantages.

(a) _____

(b) _____

ii. If no, why not? _____

_____

16. a) Assuming your direction is towards an SNA network, what are the three most important reasons for your decision? (in order of importance)

i. _____

ii. _____

iii. _____

b) Please quantify your reasons?

i. Is _____% of the decision.

ii. Is _____% of the decision.

iii. Is _____% of the decision.

17. The CRT market growth has been characterized as "explosive." What do you think are the reasons for this growth?

1. _____

2. _____

3. _____

CATALOG NO. YDKI☐☐☐

VENDOR SURVEY

1. Do you believe the IBM CRT market will continue to experience a steady growth over the next 5 years?

   YES ☐
   NO ☐

2. Will your company be an agressive competitor in this marketplace during this period?

   YES ☐
   NO ☐

3. What is your estimate of the total domestic year end 1978 installed base for 3270 type displays, including major competitors?

   < 250 K ☐
   250 - 350 K ☐
   350 - 450 K ☐
   450 - 550 K ☐
   > 550 K ☐

   Other ☐

   _____
   Specify

4. a) What share of the installed domestic market do you estimate the following vendors have ? (ask interviewee co's first)

VENDOR	% INSTALLED MARKET (U.S.)	# UNITS
IBM		
Courier		
Computer Optus		
Genesis/Word Stream		
Memorex		
Raytheon		
Sycor		
Trivex		
Olivetti		

b) How many 327X units do you believe IBM will ship during:

1979? _____ units

1980? _____ units

1981? _____ units

c) Other than IBM, who do you consider your major competitor for the following years?

1979 _____

1980 _____

1981 _____

1982 _____

5. a) There are two IBM display systems, the older 3277 or 3275 and the 3278/3276. Do you believe there is a future for the single display unit such as the 3275?

YES ☐
NO ☐

b) How many of these type systems did you ship in 1978 and how many are you forecasting to ship for 1979 through 1981?

DEVICE	1978	1979	1980	1981
3277/75				
3278/76				

6. a) Do you sell to the domestic OEM marketplace?

YES ☐
NO ☐

b) If yes, what % or how many units did you ship during 1978?

% _____, or

Units _____

c) Do you anticipate the above to change during 1979 through 1981?

YES ☐
NO ☐

i. If yes, by what % _____, or Units _____.

7. At what rate do you believe the total IBM CRT market will grow from 1977 through 1981?

1977 - 1981 _____% (annual average compounded growth)

8. In addition to the domestic end user and OEM markets, what is your unit estimate of the installed International market size ending 1978?

   Total Units _____

9. Who is your major competitor in this marketplace other than IBM?

   _____

10. In addition to the 327X display system, IBM has introduced other display products. Compared to the projected demand for 3278 compatible devices, what is your estimate of the size of the market for the following device types?

TYPE	% of Shipments 1978	UNITS			
		1978	1979	1980	1981
8775 (for the 8100)					
5251 (System 38)					

11. Will you compete in either of the above segments?

    YES ☐
    NO ☐

12. a) Do you believe that IBM will make major changes or additions to the 3270 Information Display System, either with hardware or software?

    YES ☐
    NO ☐

    b) If yes, what will the three most significant changes be: (in order of importance)

    1. _____
    2. _____
    3. _____

13. In your opinion what are the three most important features/benefits that must be offered to be competitive in this market (327X type display market)?

    1. _____
    2. _____
    3. _____

14. What are the most important criteria for success in the 3270 PCM market, other than product differentiation?

1. _____

2. _____

3. _____

15. a) Do you believe that you are successful selling to one industry or a group of industries, rather than to the entire market?

YES ☐
NO ☐

b) If yes, what are the most important industries that you serve?

1. _____

2. _____

3. _____

c) If yes, what are the most significant reasons for your success in these markets?

1. _____

2. _____

3. _____

16. How important is it to offer a complete product line -- for instance:

		Very Important	Somewhat Important	Not Important
a)	Character Printers	☐	☐	☐
b)	Line Printers	☐	☐	☐
c)	Mini Controllers (up to 8 devices)	☐	☐	☐
d)	Major Controllers (Remote)	☐	☐	☐
e)	Major Controllers (Local)	☐	☐	☐

17. a) If you offer both CRT's and printers along with controllers, is your interface between them compatible with IBM, i.e. can your CRT's go on IBM controllers and IBM's CRT's go on your controllers?

YES ☐
NO ☐

b) If yes, is yours compatible with the:

i. 3277 interface YES ☐ NO ☐

ii. 3278 interface YES ☐ NO ☐

(a) If no to the 3278, do you plan to offer it?

YES ☐
NO ☐

18. In retrospect, do you believe that this approach to interface compatibility was the right decision for your company?

YES ☐
NO ☐

19. What are the disadvantages for taking the non-compatibility approach?

1. _____

2. _____

3. _____

20. a) In user surveys, reliability and service are key issues in buying decisions. Do you offer , in most locations, IBM type service with local FE's and 2 or 4 hour response time?

YES ☐
NO ☐

b) If yes, what response time? _____hours.

c) Do you use third party maintenance for any locations?

YES ☐
NO ☐
_____% of maintenance

d) Do you, for any accounts, keep extra not billable units on site for the customer to swap in case of malfunction?

YES ☐
NO ☐

21. a) In your opinion is SNA having a major influence on the 3270 display market?

YES ☐
NO ☐

b) What would you estimate is the percentage of all communications users, with IBM or PCM CPU's, who now use SNA?

_____%

c) What will the percentage be at the end of 1980?

_____%

22. a) Is SNA compatibility necessary for your business today?

YES ☐
NO ☐

b) If SNA is not important today, then in what year will it be important?

_____.

23. a) What percentage of your CRT's attach to SDLC type controllers today?

_____%

b) By 1981? _____%

24. a) Do you offer/plan to offer an X25 network interface as an alternative to SNA?

YES ☐
NO ☐

b) If yes, what year? _____.

25. a) In what year do you believe that a flat display gas discharge, LCD, or flat CRT, will be introduced into the IBM display marketplace?

_____ year.

b) Will IBM introduce it first?

YES ☐
NO ☐

c) If not by IBM, then by whom? _____

26. With IBM shipping 3278's at an increasing rate, in what year do you estimate they will introduce a successor to the 3278 or the 3270 family?

_____ year.

27. a) With the end user market expanding so rapidly, do you see a change in the financing (leasing vs. purchasing) of CRT's?

YES ☐
NO ☐

b) What % of your current business is purchase? _____%

c) What % of your business will be purchase in 1980? _____%

d) Of your lease business, what is the breakdown of 1979 business by length of lease?

Less than 1 year	_____%
1 year	_____%
2 years	_____%
3 years	_____%
4 years	_____%
More than 4 years	_____%

28. Do you expect to be a competitor in markets other than just the 3270, that is, will you also compete against the:

8775	YES ☐	NO ☐
5251	YES ☐	NO ☐
3630	YES ☐	NO ☐

29. IBM is expanding the market through defacto submarkets, emphasizing distributed processing, stressing new interfaces, and announcing a myriad of products. What are the three key strategies necessary to counter IBM's increasing competition?

1. _____

2. _____

3. _____

a) Will these strategies require you to change the way your planning and marketing groups are currently organized?

YES ☐
NO ☐

b) If yes, in what way?

Marketing _____

_____

_____

Planning _____

_____

_____

Other _____

_____

_____

30. With regard to the international market, what is your estimate of the % of IBM and PCM's?

IBM _____%

PCM's _____%

31. What % of the total International marketplace did you ship during 1978?

_____%

32. The International market may be grouped into 6 principal geographical entities. Rank (1-6) those geographic areas by market potential for your company during 1978-1981.

Western Europe _____

Eastern Europe _____

Middle East _____

Japan/Far East _____

Australia/Canada _____

Developing Nations _____

33. a) Do you believe it is necessary to be a technological leader to be successful in the display market?

YES ☐
NO ☐

b) If yes, what are the technology areas of importance?

1. _____

2. _____

3. _____

34. What is your estimate of IBM's current ship rate?

_____ Units/month

35. a) Do you expect IBM to increase its ship rate?

YES ☐
NO ☐

b) If yes, what will it be increased to and in what time frame?

_____ Units/month by _____ (Month), _____ (Year).