A STUDY OF
INTEGRATED TELIDON TERMINAL
DESIGN CONSTRAINTS

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A STUDY OF
INTEGRATED TELIDON TERMINAL
DESIGN CONSTRAINTS

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Department of Communications
Communications Research Centre

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ELECTROHOME
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April 3, 1981

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K2H 8S2

DSS File No. 3ER.36001-0-3071
Contract Serial No. OER80-00177
Telidon Integration Study

Dear Mr. Dobbin:

Please find the original and two copies attached for the Telidon Integration Study Final Report.

Unfortunately, since two of the key personnel were tied up at Norpak while this was written, it became necessary to send the bulk of Stage II Electrohome Results in a supplement. This should arrive by April 20, 1981.

Regards,

Joe Blackburn
Technical Reporter
Videotex Marketing

c.c. Mrs. Joan Elson, D.S.S.

JB/bb

1.0 PREFACE

This report is the result of work done by the Videotex Engineering Group, Electrohome Electronics, in conjunction with Norpak Limited. Portions of the study were sub-contracted to Norpak and Electrohome's Industrial Design Group, and General Datacomm. (GDC)

Funding was provided by Contract Number 3ER.36001-0-3071 between Electrohome and the Department of Communications, Communications Research Centre. The contract resulted, indirectly, from submission of an unsolicited proposal from Electrohome in November, 1979. Various revisions and re-submissions resulted in a signed contract in August, 1980.

The intent of this contract was to integrate the Telidon decoder with communications devices and a display monitor and to study and resolve the resulting problems in so doing.

Originally, the prototypes were intended to be consumer-oriented, but the Market Analysis indicated a current need in the business community, with the resulting design thrust ammended to create a business-like terminal rather than an integrated consumer style TV.

In order to accomplish the goals set out above, it has been necessary to work closely with Norpak, G.D.C. and the staff at Communications Research Centre.

The assistance and cooperation of all parties concerned is gratefully acknowledged.

P. Anthony
T. Kuruc
S. Kustedjo
G. Russell
J. James
J. Blackburn
March 30, 1981

2.0 CONTENTS

1.0 Preface

2.0 Contents

3.0 Executive Summary

4.0 Stage I Report

4.1 Phase I
- 4.1.1 Feasibility Study
- 4.1.2 Detail Role Definition of Each Party

4.2 Phase II
- 4.2.1 Market Study - Feature Determination
  OEM Cost Indication
- 4.2.2 Industrial Design Study by Electrohome

4.3 Phase III
- 4.3.1 Modem Standards, Interface Problems,
  Common Carrier Protection and
  Auto Dial Features
- 4.3.2 Problems associated with use of a
  common power supply
- 4.3.3 Interference Testing with Consideration
  of regulatory and DOC approvals
- 4.3.4 Shielding and Filter Design
- 4.3.5 Packaging Design with transit testing,
  and environmental conditions considered
  and tested
- 4.3.6 Prototype Construction

4.4 Phave IV
- 4.4.1 Contract Status Review and Continuation Approval

5.0 Stage II Report

5.1 Phase I

5.1.1 Feasibility Study

5.1.2 Detail Role Definition of Each Party

5.2 Phase II

5.2.1 DOC Teletext Testing

5.2.2 Market Study

5.2.3 Interference Testing

5.2.4 Group Delay Study

5.2.5 Shielding Design

5.3 Phase III

5.3.1 Interference Testing (Supply Lines)

5.3.2 Packaging (Transit and Environment Tests Revisited)

5.3.3 Filtering Design

5.3.4 Prototype Construction

5.4 Phase IV

5.4.1 Contract Status Review and Continuation Approval

6.0 Graphic Aids

7.0 Appendix

3.0 EXECUTIVE SUMMARY

The subject of this report is the analysis of problems encountered integrating a Telidon Decoder and communications device with a television type display to produce a single videotex terminal package. Thus eliminating interwiring complextities, cost and waste of space caused by the present multi-box approach.

The resulting market studies indicated a need for a complete, small business videotex package to interconnect with the telephone network for the 1981 market place and this research fell nicely in line with Electrohome's, already started, business terminal product development.

Stage I resulted in the successful installation of a 13" colour display, Mark III decoder, and split speed modem into a 22 x 17 x 14" prototype with the resolution of interfacing, interference and environmental problems. Further, Electrohome's Production Engineering Group have used the results of this stage to complete development of a product for production, under EDP funding, for market introduction earily in 1981.

Stage II resulted in construction of a terminal prototype similar to that is Stage I; except instead of having a mode communication interface installed, a TV broadcast type tuner, 'IF', detector and teletext decoder was used. These assemblies, packaged in the same box provided a unique set of interfacing, interference and environmental problems to be solved. However more study and product development will be required before a marketable product will result.

One of the main stumbling blocks to marketability, of this type of product, is the lack of data format and rate standards. Further, a terminal with teletext capability but not normal colour TV viewing capability has questionable market appeal.

The construction of this Stage II prototype has resulted in valuable information for the construction of consumer videotex receivers for the probable 1984 market place and of captioning decoders in the near future.

4.0 Stage I Report

4.1 Phase I

4.1.1 Feasibility-Study Stage I

Electrohome's first proposal of November 17, 1979 provided the basic list of tasks for a contract which was finally awarded August 27, 1980.

Unfortunately, since the state of the industry had changed radically within the intervening months, the original thrust of the proposal had become outdated.

For example, the Mark II had evolved into the Mark III, Electrohome had since acquired rights to the Telidon technology, and the market place had begun to swing towards the business market place as opposed to consumer.

As a result, a new work statement was drafted and submitted to the scientific authority, CRC, and an ammendment requested from DSS.

The new task list was "piggy backed" upon the existing work statement. Electrohome had, meantime, commenced to design an integrated business terminal. The overall effect of the ammendment was to condense the expected results of the originally proposed Stages I, II and III into the new Stages I and II.

A possible third stage was discussed and it was decided that the details of this stage would be reviewed upon completion of Stages I and II.

4.1.2 Stage I - Role Definition

The intention of the study was to insight into the problems of total integration.

It was agreed that Electrohome, as prime contractor, would work on the overall terminal integration, packaging and marketing responsibilities.

Electrohome's experienced Industrial Design department addressed the aesthetics of the integration to help foster its marketability. In addition, we conducted an ungoing market study to determine the interfacing needs of the user, so that the sets produced during this stage would provide samples for the 1980-1981 field trials.

Norpak was sub-contracted to investigate and advise design constraints, to implement hardcopy from the screen buffer, keypad Telidon code re-allocation, Mark III to G07 and Mark III to modem interface problems, autodial support, and minimum 80 character terminal software.

Norpak were also to develop an autodial software/hardware implementation, starting in this stage and to be completed and installed in the next.

Finally Norpak critiqued and advised Electrohome on the total integrated packaging, regulatory approval work, and common power supply problems.

Cost indications are given for likely 1K, 10K, 100K sales costs for the above mentioned features in the final report supplied by Norpak. (see Appendix 'A')

General Datacomm (GDC) in Ottawa was contracted to design, construct and test a 1200/150 split speed modem for this application. GDC also accepted responsibility for obtaining DOC and related approvals for this assembly. No cost to the resulted from this activity, since it led to a product requirement from GDC for Electrohome.

This stage would thus identify problems associated with producing a business terminal for use in telephone network, which in turn could provide volume production opportunities required for cost reductions.

4.1.3 Stage I Tasks - Electrohome

Tasks

Phase I

A) Feasibility Study
B) Detail Role Definition of Each Party

Phase II

A) Market Study - Feature Determination - OEM Cost Indications
B) Industrial Design Study by Electrohome

Phase III

A) Modem Standards, Interface Problems, Common Carrier Protection, & Auto Dial Features
B) Problems associated with use of a common power supply

C) Interference Testing with Consideration of regulatory & DOC approvals
D) Shielding and Filter Design
E) Packaging Design with transit testing, and environmental conditions considered and tested.
F) Prototype Construction
G) Iteration
H) Additional (2) Prototype Construction

Phase IV

A) Final Report
B) Contract Status Review and Continuation Approval

4.1.4 Stage I Task List - Norpak

Norpak was to investigate and report the design constraints to implement:

a) The required hardware and software for hard copy output for the Mark III frame buffer and recommend alternative means of achieving hard copy of Videotex information.

b) Re-allocation of the Mark III Telidon command codes to allow clustering of the functions on a standard alpha-numeric keyboard.

c) The hardware and software required to provide auto dial facility using the Mark III and General Datacom split spped modem.

This package was to include dial up directly from keypad using "F" sequence entry and auto dial of stored numbers. Norpak was to recommend means of storing these numbers which should be re-definable by the user at any time.

d) A minimum software package to provide 80 character terminal features using Norpak's alpha board in conjunction with the Mark III.

Electrohome requested Norpak to review their own experience with terminals and advise which features are most demanded by users. Norpak would also advise and aid Electrohome with packaging, common power supply, regulatory approval, G07 to Mark III and modem to Mark III design problems, and DOC approval.

Finally, Norpak would include market cost estimates for all of the above feature additions for sales, in quantities of 1K, 10K, 100K units in the final Stage I report.

4.2 Phase II

4.2 Phase II

4.2.1 Market Study - Stage I

To determine market needs several sources were used.

a) Trade Show Exposure at:
   - Info 80 in New York
   - Siggraph in Seattle
   - Videotex show in Liege
   - Videotex show in Dusseldorf

b) CVCC sub-committees
   - Market and industrial strategy
   - Standards

c) Market Studies
   - "The Viewdata/Videotex Market in Europe" (Frost & Sullivan - Dec./80)
   - "Home Telecommunications in the 1980" (International Resource Development Inc. April, 1980)
   - RS232 Plug/Socket Research by GML Information Services in Massachusetts. (Appendix B)

   - Misc. in house studies of the colour graphics area.

d) Initial sales literature response to possible feature options.

e) Major customer input (mainly Infomart, Toronto)

The main indication was that the first market (1980-82) for Videotex would be business oriented since the initial cost of terminals and service will be high. A possible second up target market (1981-82) will be for computer aided learning. The last market area will be a consumer type emerging about 1984.

The first commercial media to be used will be telephone since interconnection and regulatory constraints are far less than that of broadcast/cable cast. Also, RS232 closed user applications will be required in the short term. This dictates that an RS232 input as a minimum is required on a business videotex terminal and for the 1981-82 market a telephone modem option would be necessary.

In the case of the terminal with a modem it was felt that a split speed (1200/150) would be sufficient and represented a substantial cost saving over a full duplex (1200/1200) unit which is typically three times more expensive. Further, since no one is likely to type faster than 150 characters per second and inter-terminal messaging is not available, 1200 baud reverse channel is somewhat wastefull at this time.

A copy of the market research on the RS232 connector is attached in appendix B. This study indicates that the majority of terminal manufacturers reviewed use a female connector with pin 2 tied as transmit, pin 3 as receive, pin 4 as RTS and pin 5 as CTS, instead of the male plug used on the present Mark III decoder.

(Note that the GML reply of February 19, 1981 sights 20 major companies used; the February 26, 1981 reply indicates those found to use the female plug; and the March 4 reply indicates the pin connection. See appendix B)

This information was presented by Mr. Dave Knight of Electrohome at the CVCC Standards Meeting of March 13, 1981 and Electrohome plan on implementing the female plug on sets produced after June, 1981.

Using the above information the minimum terminal with and without a modem was configured and the latter used for evaluation in this stage. (OEM price forecast is indicated in appendix)

Additional features were reviewed with mixed interest from the market place.

a) 80 character /24 line and dumb terminal mode
b) RGB input/output ports
c) local storage (similar to Hemton)
d) higher resolution
e) 220V/50Hz capability
f) baud rate and parity switches external
g) video/data multiplexing

The dumb terminal alternate mode seemed to be a useful tool for closed user groups and Computer Aided Learning applications. This feature may cost as much as $700.00 extra, but can be justified in some cases.

The idea of RGB outputs for display transfer to a larger screen or recorder has merit with an approximate $80.00 price tag, in the latter case, this feature greatly simplifies the issue of obtaining hard copy. But RGB input to utilize the internal monitor was generally discounted.

Local storage is ideal for show demonstrations and could be obtained on a special build basis, pending negotiations between Electrohome and Hemton, but has limited volume potential.

The balance of the above points are feasible but little demand was found for them, at this time.

The next important requirement uncovered was that the videotex terminal parts should all be in one box and of a size to fit into a manager's office. Additionally, the input device should be a keypad with full alpha-numeric capability, instead of a keyboard which may make a "manager type" feel compromised. However, a keyboard was found acceptable for computer aided learning applications and future office applications.

Use of a keyboard presents another problem concerning Telidon key codes. For example, the Telidon number 1 to 9 and the normal ASCII numbers use different binary codes. This problem forces the keyboard or keypad format to include a special key area reserved for Telidon commands, instead of simply using a shift off of the normal ASCII number keys. This study addresses a means to correct this problem.

There was consideration given to user controls and it was felt that the less controls the better. The user should be presented simply with an on/off switch, keypad and - in telephone network applications - a telephone. Other controls such as contrast, brightness, focus, modem/RS232 selector, etc. should be mounted on the back and normally set up once upon installation.

4.2.2 Industrial Design

Industrial Design

After careful consideration, consultation with major customers, and review of terminal product at trade shows, a compact 13" colour terminal was designed with a complementary key pad, keeping the market study results in mind. Consideration was also given to the possible inclusion of a modem or teletext communications device and an 80 character/24 line controller from a mechanical stand point.

Additionally, it was felt that a fan would be objectionable, therefore the design lends itself to convection cooling.

4.3 Phase III – Technical Analysis

4.3.1 Modem, Common Carrier Protection

Electrohome conducted a market survey of available and custom designs, and serious consideration was given to General Datacomm, Racal-Vadic, and Gandalf. Modems were examined according to quality, deliverability, service and repair, technical assistance availability, pricing and sub-licensing capability.

General Datacomm was chosen, since thay had compatable designs readily available. They were sub contracted to prepare a unit which combined two existing DOC approved designed unto one board, and to assure Common Carrier protection. GDC used an approved D/A interface circuit.

Subsequently, Electrohome and Norpak recommended modem frequency specifications to the CVCC Standard sub-committe in September, 1980 and Bell compatable frequencies for 1200 baud receive and 150 baud transmit operation were set up, as a tentative standard.

Mark III to G07 Interface

An interim interface circuit, composed of a simple D.C. buffer, was designed to provide the necessary 2.5V p-p (100 IRE) input signals to the G07 monitor section, from the RS170 Mark III video outputs. Sync operation circuitry was also included for the CRT horizontal and vertical sync.

In order to eliminate video signal noise and D.C. level inatability from the Mark III decoder, it will be necessary to design an AC coupled amplifier with DC restoration circuitry to replace this interim interface.

It was then determined that brightness and contrast controls for the monitor were desirable. The brightness control has since been implemented, and provisions are being made to accommodate the contrast control.

4.3.1 Terminal Autodial

Although Electrohome's proposed approach is not autodial in the strictest sense, it does constitute a network addressing device. This approach was chosen over the limited storage of specific telephone numbers in the terminal.

The General Datacomm modem used in our terminal is capable of being interfaced to the Telco network through a permissive connection.

In addition, there is provision for the circuitry to use a terminal supplied pulse stream to go on and off the line, simulating the dialing function of the telephone.

Using this method, the operator initiates the dialing function from the keypad by keying in the function number for "dialing", followed by the telephone number into a pulse sequence and passes these on to the modem through the "off hook" (OH) signal line. The terminal would look for obvious errors such as a non-numeric input sequence and display the resulting error message on the CRT.

At the end of the dialing sequence our terminal would leave the OH signal line low, eliminating the requirement for a talk-data switch to latch the modem to the telephone line. The line would be released by the modem under any of the following conditions:

1) Loss of Power
2) Loss of data carrier signal
3) High OH signal line

The first condition is probably the easiest way for the user to terminate the call. This requires only that the terminal be turned off.

Secondly, if the session is terminated by the host computer there will be loss of the data carrier signal which will in turn cause the line to be released.

The third condition would force reset, when changing modes or starting another call.

Eliminating the telphone from the list of peripheral equipment requires some way of monitoring the telephone line to determine if a connection has been made. We propose to do this by incorporating a speaker so the user can actually listen as the call is being placed. This way, a busy line or wrong number can be immediately detected, and terminated.

The speaker would be disconnected once the call is successful. This may be accomplished by electronically gating the speaker off in the presence of the data carrier signal.

4.3.2 Power Supply

The G07 monitor used has its own power supply. A switching power supply was chosen for the remaining circuitry to provide +12V, -12V, +5V, -5V. This choice provided the advantages of power efficiency, light weight and small size. In addition, the supply conforms to the temperature requirements of the Mark III board at 40°C. A line isolation transformer is included for safety, since signal ground must be used by perpherial devices.

In order to accommodate the volatile 4116 RAM's, the power supply must be sequenced. The -5V must come up first and drop off last. The make the Mark III board less susceptible variations in RAM suppliers, and temperature susceptibility, the Mark III will need some reworking. The frequency of the power supply must be locked in synchronization with the horizontal frequency of the monitor to improve the quality of the display. Work at Electrohome is ongoing in this regard.

Failure of the -5V supply has definately been proven detrimental to the 4116 RAM's. Additional work is also required to avoid this fault mode.

4.3.3 Interference Testing

a) Line conducted radiation testing was done in Electrohome's RF Isolation Booth using the Industry Standard (IRE) test jig mounted in the centre of the booth.

Equipment consisted of a Hewlett Packard Spectrum Analyser and a '0 to 10 MHz' RF unit. The IF unit was set 3 kHz bandwidth.

The unit was checked for line conducted radation with no filtration, then with several open air filtering devices available in house, and finally found to be controlled using a commercially built, enclosed line filter. This not only rejected spurious radiation to a great degree, but also brough the unit to well within existing consumer TV standards. (See figure three and four).

b) RF radiation was checked in the isolation booth, using six turns of insulated wire coil as an antenna connected to the input of the spectrum analyser.

It was found that spurious RF radiation was actually similar to readings taken on similar computer peripheral units employed in house. However, this test method was quite crude since no standard measurement procedures exist for this type of radiation on an antennaless terminal.

4.3.4 Approval Status

Approvals were initially delayed due to the fact that the regulatory bodies seemed to be unsure of what category the unit should be filed under. It has since been classified under a new catagory - Telidon Videotex Integrated Terminals - in Canada.

CSA approval for the terminal has been applied for, and is expected in mid April, 1981. U.L. application will be set up in the future with approval expected 3 to 4 months.

The modem approval is expected from DOC in about 3 to 4 weeks to be followed by FCC approval in 6 to 8 weeks from the date of this report, with GDC expediting the approval.

4.3.5 Transit and Environmental Testing

Standard Industry Quality Analysis was done for this unit, including:

- 1 hour shake table testing
- 18" drop testing
- 24 hour burn-in
- elevated temperature testing, etc.

As a result of these tests, packaging adjustments were made to protect switches and knobs projecting from the rear of the set. Further, 275 16 test double walled carton was decided upon, with "Instapak" pads covering the top and bottom, and centring the unit in the carton.

No transmit failures of packed units have occurred to date.

Life testing is ongoing to establish the targetted 20,000 hour MTBF figure. The life test conditions are accelerated by using high line (132 VAC, 60 Hz) power, elevated temperature ($32^{o}C$) and switched line ($2\frac{1}{2}$ hours on, $\frac{1}{2}$ hour off sequences). This activity has already uncovered several design flaws in the Mark III and the switch mode power supply design which are being corrected.

As a result of operating temperature tests, further heat sinking and Mark III design changes are being considered. At present the terminal's recommended maximum operating temperature is limited to $32^{o}C$.

4.3.6 Prototype Construction

Three prototype units were constructed with 13" monitor, power supply, decoder and modem in this stage.
The terminal may be seen in figure 5 and 6.

The autodial and terminal software plus autodial parts were left out in this stage with expected retrofit in Stage II.

Additionally, the issue of key codes being changed was left to the next stage.

4.4 Phase IV

4.4.1 Contract Statud Review - Stage I

It was noted that the Stage I part of this study was essentially completed and the following items would be carried into Stage II.

a) Modem auto-dial software/hardware implementation for dial from the keypad function.

b) Terminal software/hardware implementation using VC404 type functions.

c) Telidon command key code re-allocation using the 80 Hex off-set.

The conclusion to drop the printer function was discussed noting complexity and timing limitations and that an alternative exists using an 'RGB' recorder.

A waiver on the acceptance test plan was agreed upon in light of the complexity and lack of slide release from D.O.C. G. Dobbin was to follow this item up with a letter to J. Elson. (See March 31, 1981 letter in Appendix D).

In conclusion Mr. Dobbin was requested to give approval for continuance into Stage II and he agreed.

Stage II was expected to go as planned, except that Norpak would not be able to deliver the sync option required. G. Dobbin agreed to review and respond to this issue. (See March 31, 1981 letter in Appendix D).

The deliverables were expected to be completed in time for March 31, 1981 deadline. Norpak indicated late delivery (March 23, 1981) of the teletext modules, with possible rework in April.

5.0 Stage II

STAGE II

Notes: Stage II contains only Phase I, and part 5.2.2 (Market Study) of Phase II. The remainder will follow in a supplementary report on April 20, 1981.

5.1 Phase I

5.5.1 Feasibility Study - Stage II

Upon reviewing the results of Norpak's efforts and those of Electrohome's terminal integration a proposal of the tasks to proceed in Stage II was drawn up. This proposal was presented to the scientific authority during a conference called March 4, 1981 and a request to proceed was granted.

5.1.2 Role Definition - Stage II

During Stage II, Electrohome was to investigate the problems arising from integration of the Telidon and teletext decoder with a television tuner. The terminal which resulted from Stage I was to be augumented with a television tuner, and the modem replaced by a Teletext module.

The objective was to study the E.M.I. effect of the Telidon and teletext decoders' electronics on the tuner, as well as any further problems due to radiation, heat and sharing of the power supplies. In addition, this stage would examine problems associated with group delay.

The knowledge gained in this stage would aid Electrohome in addressing the design problems associated with producing television teletext compatible terminals for possible business, consumer and captioning markets.

Norpak was sub-contracted in this stage to provide an implementation of a teletext/external sync assembly with supporting software to work with a Mark III card as supplied to Electrohome and guide Electrohome in integration into a terminal.

Norpak investigated the constraints on summing an 80 character controller video with the Mark III video and implemented a terminal software package per that recommended in Stage I.

Norpak was to finalize the auto dial implementation in this stage and it was to be installed in the three terminals from Stage I.

The issue of a hard copy interface was to be re-visited and a design implemented if possible. Norpak was to include with their three teletext modules, three external sync assemblies and each module would be required to operate at separate frequencies. (Unless notified otherwise, by DOC, two of the assemblies would operate at 4.6 MB and one would operate at 3.8 MB) A recent adjustment to these

requirements modified the data rates for all three to be 4.6 MB, the external sync option was deleted due to design difficulties at Norpak, and the results of Stage I resulted in dropping the mechancial hard copy study for the 'RGB' out approach with a photographic recoder such as the image resources device.

Finally, Norpak advised during Stage I that summing the alpha and Mark III video would be a formable task and outside the limitations of this contract since the two assemblies use unsynchronized and vastly different video clock rates.

Norpak would also aid Electrohome in regulatory and DOC approval consideration and give IK, 10K and 100K sales cost estimates for the above features. (To be provided in Stage II Supplement).

5.1.3 Stage II Task List - Electrohome

Tasks

Phase I

A) Feasibility Study
B) Detail Role Definition of Each Party

Phase II

A) DOC Teletext Testing
B) Market Study
C) Interference Testing
D) Group Delay Study
E) Shielding Design
F) Iteration

Phase III

A) Interference Testing (Supply Lines)
B) Packaging (Transit and Environment Tests Revisited)
C) Filtering Design
D) Prototype Construction
E) Iteration
F) Additional (2) Prototype Construction

Phase IV

A) Final Report
B) Contract Status Review and Continuation Approval

5.1.4 Stage II Task List - Norpak

Norpak was to advise and support Electrohome in the integration of their teletext assembly into Electrohome's business terminal. Details of contents of this technology are restricted and dependant on the results of separate technology transfer discussions still taking place. The teletext assemblies were to operate at 4.6 MB.

Norpak was to implement if possible, an 80 character terminal software package with the features outlined in Stage I and provide three alpha assemblies as a deliverable in this stage.

As in Stage I, Norpak would also provide a final Stage II report, cost estimates for all of the above feature additions for sales, in quantities of 1K, 10K and 100K units.

Norpak would also support Electrohome with packaging, common power supply, regulatory approval, and DOC approval work. Norpak will prepare an auto dial software/hardware package per the findings of Stage I, for installation into Stage I terminals, at Norpak.

5.2 Phase II

5.2.2 Market Studies - Stage II

5.2.2 Market Study - Stage II

The unit to be assembled during this stage was a teletext terminal without normal colour broadcast reception capability.

This unit proved to have questionable market appeal, but served to investigate the associated problems in using teletext, decoder and display electronics in close proximity of a standard television tuner. Further the interfacing problems between the teletext and receiver electronics were investigated.

The price of such a unit as this should be no more than $200.00 above those indicated for the basic terminal with telephone modem described in Stage I. The receiver electronics is the main cost contributer, since the modem and teletext electronics costs should be similar in the quanitities indicated.

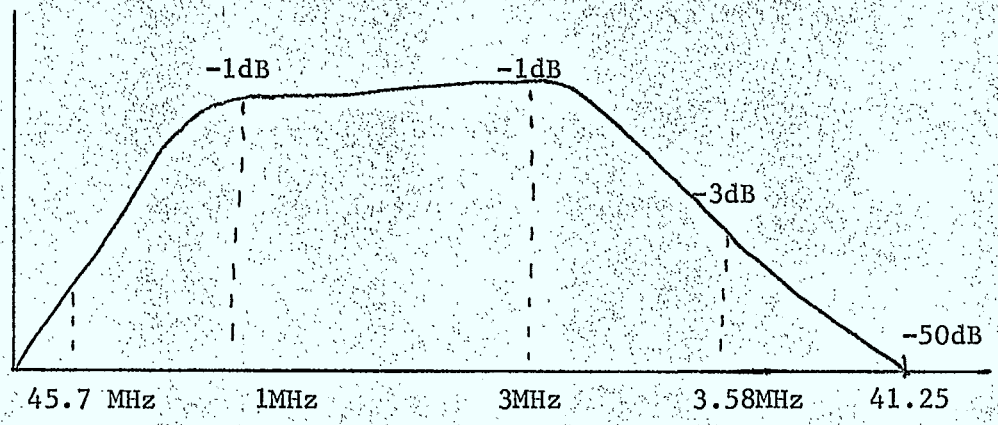
Teletext usage as a media for other than trial or closed user applications will be restricted until transmission rates, etc. are standardized in North America.

5.0 Graphic Aids

Electrohome Teletext Findings

1. RF & IF overall frequency characteristics.

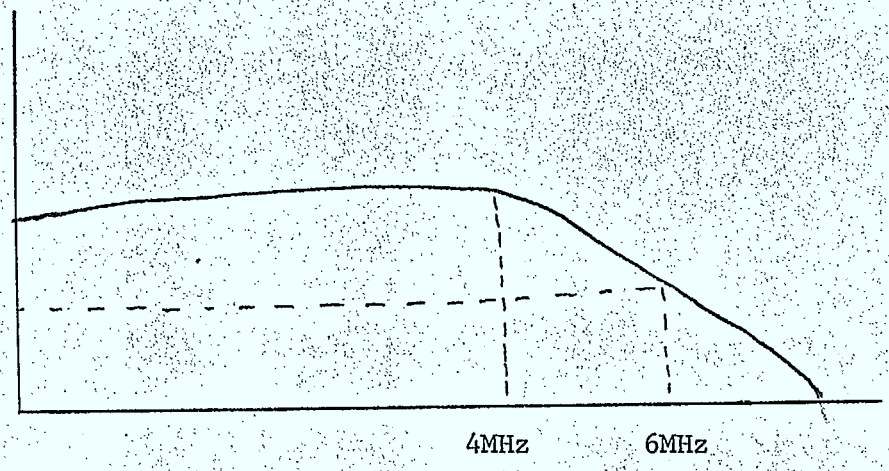
Figure 1



This graph is obtained from "Envelope Delay Measuring Set" (Shibaski Model 201/1) using amplitude sweep response.

2. After demodulation the response was as in figure 2.

Figure 2



(Sound Notch Out)

1451

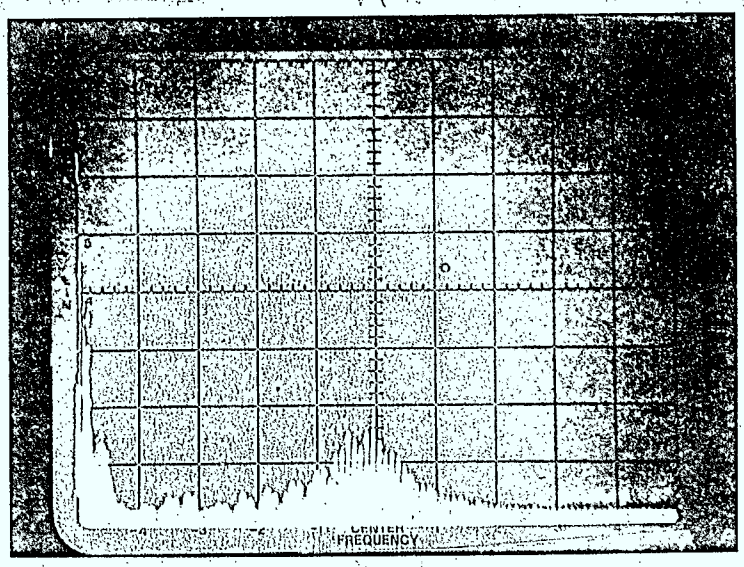
Feb 19/81

ELECTROHOME ELECTRONICS

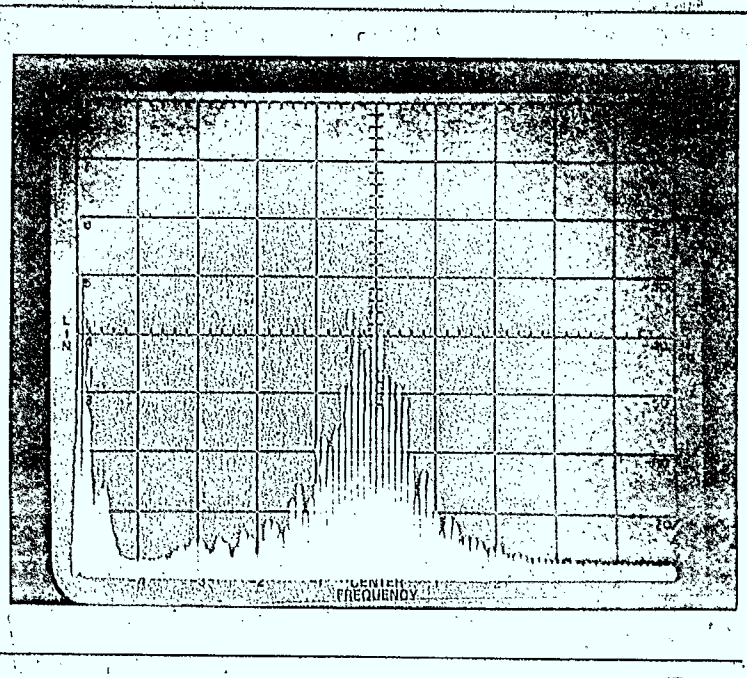
POWER LINE CONDUCTED RADIATION RECORD

PRODUCT IDENTIFICATION		MEASUREMENT EQUIPMENT	
CHASSIS TYPE	TELCO-R-NK	SPECTRUM ANALYZER	H.P. 141-T
MODEL NO.	T01-014	CENTER FREQUENCY	1.0 MHZ.
SERIAL NO.	ES-004	SCAN WIDTH	0-2 MHZ. 200 KHZ./DIV
MANUFACTURED BY		BAND WIDTH	3 KHZ.
DATE OF MANUFACTURE		VERT. SENSITIVITY	100uV/DIV.

.1mV/DIV



SIDE "A"



SIDE "B"

MEASURED BY

Figure 3

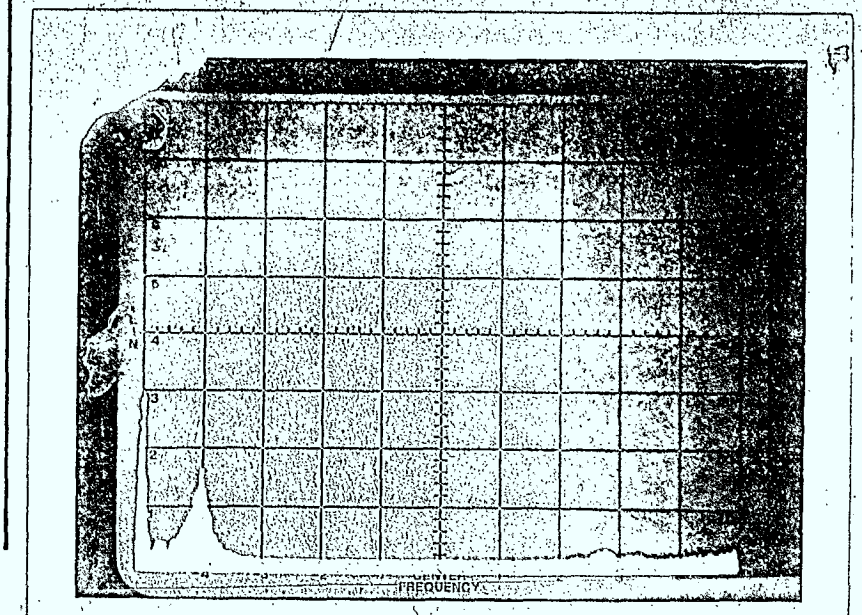
#451

ELECTROHOME ELECTRONICS Feb 19/81

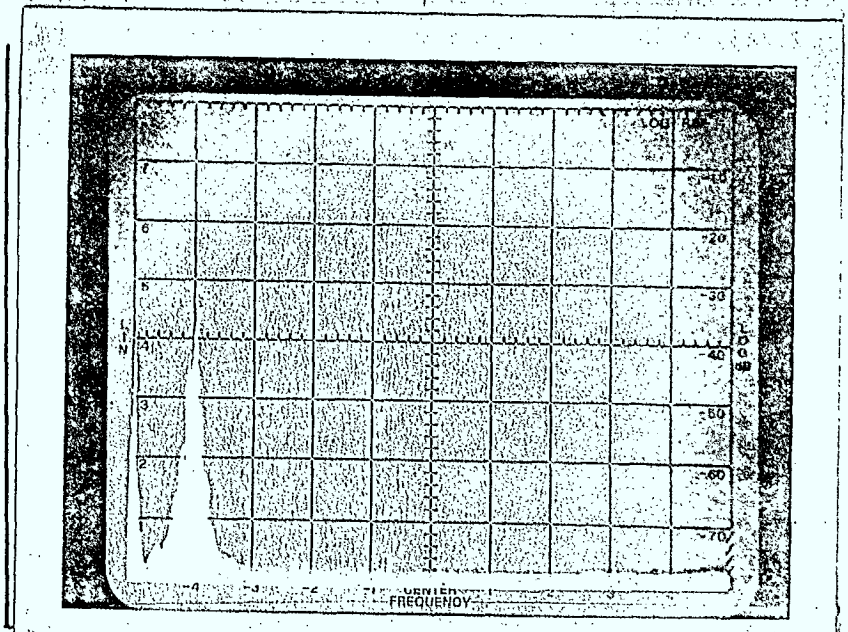
POWER LINE CONDUCTED RADIATION RECORD

PRODUCT IDENTIFICATION		MEASUREMENT EQUIPMENT	
CHASSIS TYPE	TELCO - R - MK	SPECTRUM ANALYZER	H.P. 141 - T
MODEL NO.	701-014	CENTER FREQUENCY	5 MHZ
SERIAL NO.	ES-014	SCAN WIDTH	0-10 MHZ (1 MHZ/DIV.
MANUFACTURED BY		BAND WIDTH	3 KHZ
DATE OF MANUFACTURE		VERT. SENSITIVITY	100uV./DIV.

.1 mV/DIV



SIDE "A"



SIDE "B"

ED BY

Figure 4

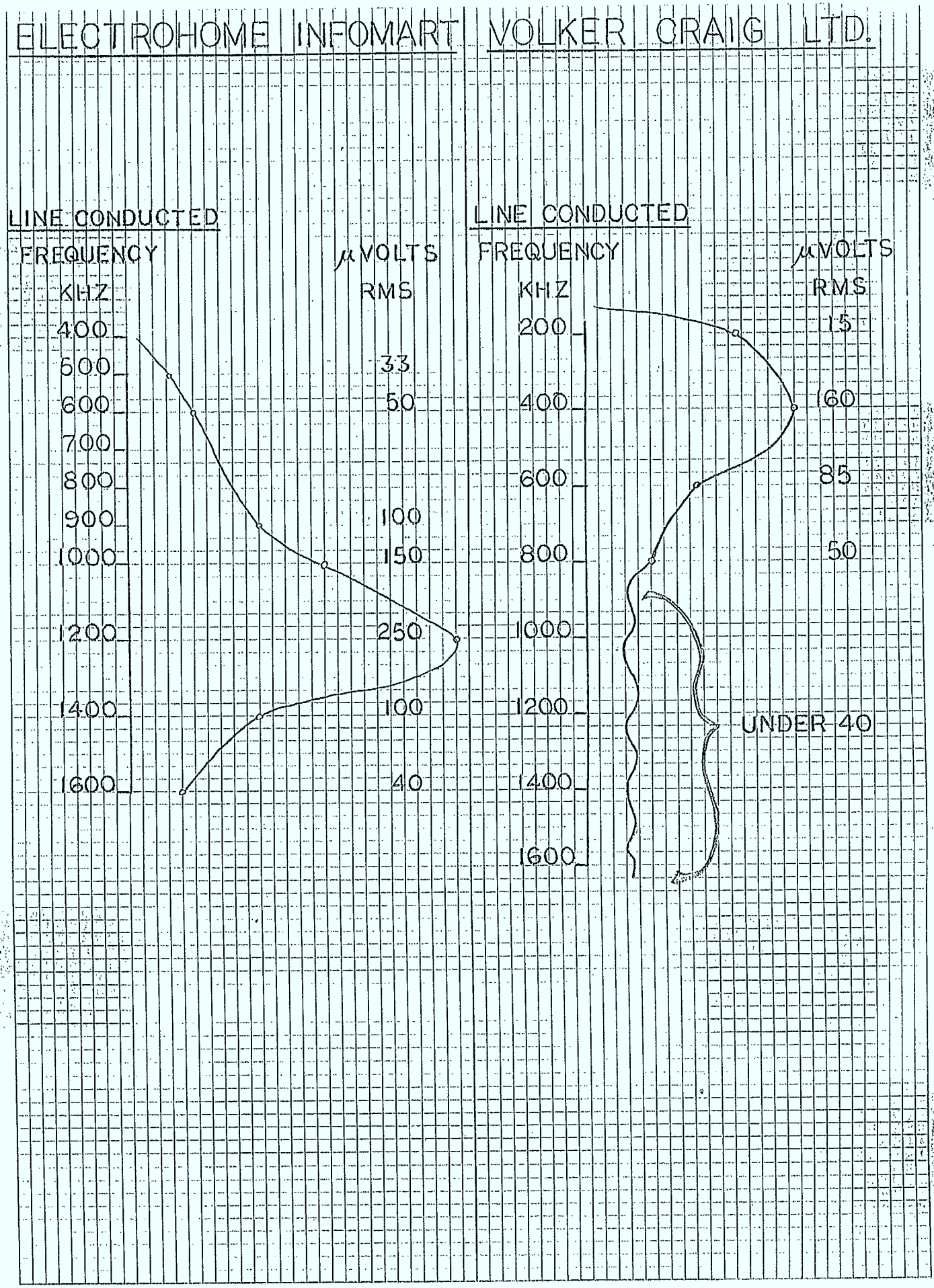

ELECTROHOME INFOMART VOLKER CRAIG LTD.
LINE CONDUCTED
FREQUENCY
KHZ
400
500
600
700
800
900
1000
1200
1400
1600
μVOLTS
RMS
33
50
100
150
250
100
40
LINE CONDUCTED
FREQUENCY
KHZ
200
400
600
800
1000
1200
1400
1600
μVOLTS
RMS
15
160
85
50
UNDER 40

Figure 7

APPENDIX A

Norpak Report

P348 REPORT
ELECTROHOME
ELECTRONICS
DOCM: P348

NORPAK LIMITED
PAKENHAM, ONTARIO
CANADA
KOA 2X0

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Rev 1 10-Feb-81

TABLE OF CONTENTS

1.0 Introduction

2.0 Hard copy

3.0 Key codes

4.0 Auto-dial

5.0 ASCII terminal

6.0 Summary

7.0 Conclusions

8.0 Costing

9.0 Appendix

1.0 Introduction

This report, for Electrohome Electronics , details the constraints involved in implimenting additional functions on a Norpak Telidon MK III terminal.

Functions include hard copy, re-allocation of key codes, auto dial, and an ASCII terminal. Constraints are outlined from the hardware and software aspects.

Costing of each of these functions is outlined.

2.0 Hard copy

Hard copy output for Videotex information may be categorized into two different sections:

a) textual only output
b) full graphics output

While character only printers are readily available, they severely restrict the output available. For the purpose of this report, this item will not be considered.

In the area of graphics hardcopy, a further subdivision occurs:

i) monochrome output
ii) colour output

There are currently two major types of colour hardcopy available, optical and impact, both of which are relatively expensive solutions. As an example, a Trilog Colourplot 100 printer costs in excess of $10,000.

One type of non-colour hard copy device possible is a thermal printer, a Trendcom 100. The major characteristics of the unit include:

i) 40 character per second print speed
ii) full 96 character set
iii) bi-directional printing
iv) ten character per inch
v) TTL interface, (RS232 optional)
vi) special paper used
vii) graphics ability, 240 dots wide

The display format of the MK3 Telidon Decoder is 256 pixels horrizontally and 200 pixels vertically. As a result, to print an entire screen of information will take approximately 30 seconds. The major restriction is that only 240 of the 256 dots will be printed.

There are two problems that occur with printing graphics. Normally the printer will print bi-directionally, however when doing so it cannot maintain the consistency of printing from line to line. Images with a dark background will have an inconsistent density. According to the manufacturer, this can be avoided by using carriage returns and printing unidirectionally. (It is believed this problem occurs because of heating of the print head).

This type of printing, however, uses the printer's

margin switch, which can introduce occasional one dot offsets.

The solution to these problems is three fold:

i) print bi-directionally to prevent the dot offset

ii) map black pixels on the screen to white dots on the printer to reduce the amount of black background.

iii) possibly insert a pause after each line to cool the print head and decrease print inconsistency.

Another aspect which must be considered; the printer is a strictly a monochromatic device whereas the display screen is in colour. One method of solution is to map the colours to the printer based on the brightest colour, green, and the median point for grey scale. See figure 2-1.

One drawback of this printer is that special paper must be used. Based on published prices from the manufacturer, a single sheet (12 in. long) will cost approximately 3 cents.

An area which requires further investigation is the aspect ratio of the printing. The dot spacing across the line versus the spacing down the page can make a circle into an ellispe. Insufficient data was available at the time of this report.

Interfacing of the Trendcom 100 printer may be either parallel 8 bit or serial RS232. The parallel interface is not only a standard option, it is also likely to be faster by virtue of the lesser amount of overhead of the interface at both ends (MK3 and Trendcom).

There is currently no spare interface on the MK3 terminal for hard copy purposes. What is required is a byte parallel interface with a strobe time, and a "busy" recognition flag to monitor the printer's status. This can take the form of a standard microprocessor parallel interface with the appropriate buffers and receivers for operating the unit over several feet of cable.

Colour	Print output
Grey 0	White
Grey 1	White
Grey 2	White
Grey 3	White
Grey 4	Black
Grey 5	Black
Grey 6	Black
Grey 7	Black
Xpar	White
Blue	White
Red	White
Magenta	White
Green	Black
Cyan	Black
Yellow	Black
Blink white	Black

Figure 2-1 Colour map to printer

3.0 Keycodes

At present, Norpak's MK3 Telidon terminal utilizes two different input devices for control and input functions of the unit. Both devices, a keypad and a keyboard, have a common set of key codes explicitly used for operating the unit as a PDI terminal.

Currently, the Telidon command codes are based on 24 separate keys as depicted on the keypad, figure 3-1.

In operation, nineteen of the keys are transmitted from the terminal to the host while the remaining five are executed locally only. Local functions are TV, V/T, . The nineteen keys will cause a character to be transmitted from the unit, that match an ASCII character i.e. while a 0 is depicted on the keypad, code $EF is sent to the terminal, which in turn transmits an ASCII "0" ($30) to the host. See figure 3-4, first 2 columns.

The keyboard (Norpak KB5.0) includes the basic ASCII character set as well as the keypad keys. See figure 3-2. The row of keys across the top of the board and the pad on the right comprise the entire set of keypad codes, i.e. 0-9, S,F,R,<,>,." . TV V/T . These keys are not to be confused with any of the ASCII keys, as the codes generated are quite different. See figure 3-3.

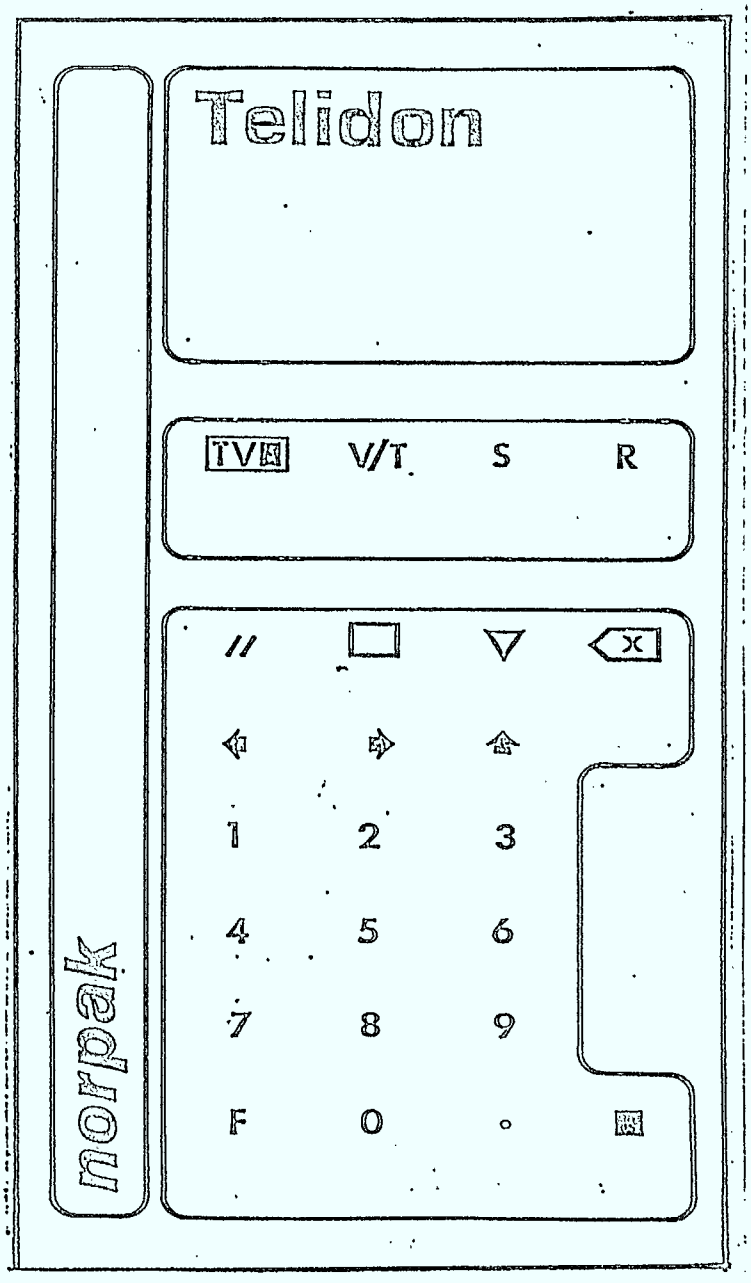
By clustering the Telidon key codes together with the ASCII a smaller alpha-numeric keyboard could be used, with the associated cost saving. There are two problems which must be considered:

1) the terminal must be able to distinguish Telidon command from the ASCII characters, and

2) compatibility of any proposed coding scheme with units in the field.

The keyboard (KB5.0) has two different operating modes. As a keyboard, codes are transmitted on a one by one basis to the host computer. Codes sent by the keybard, acting as keypad, are not sent immediately but buffered locally in the terminal until a terminator character is sent ( ). For this reason, the Telidon terminal must be able to distinguish a difference in the key codes.

Figure 3-1 Keypad layout



KEY	CODES Normal	Shift	Ctrl
A	61	41	01
B	62	42	02
C	63	43	03
D	64	44	04
E	65	45	05
F	66	46	06
G	67	47	07
H	68	48	08
I	69	49	09
J	6A	4A	0A
K	6B	4B	0B
L	6C	4C	0C
M	6D	4D	0D
N	6E	4E	0E
O	6F	4F	0F
P	70	50	10
Q	71	51	11
R	72	52	12
S	73	53	13
T	74	54	14
U	75	55	15
V	76	56	16
W	77	57	17
X	78	58	18
Y	79	59	19
Z	7A	5A	1A

Figure 3-2 KB5 key codes

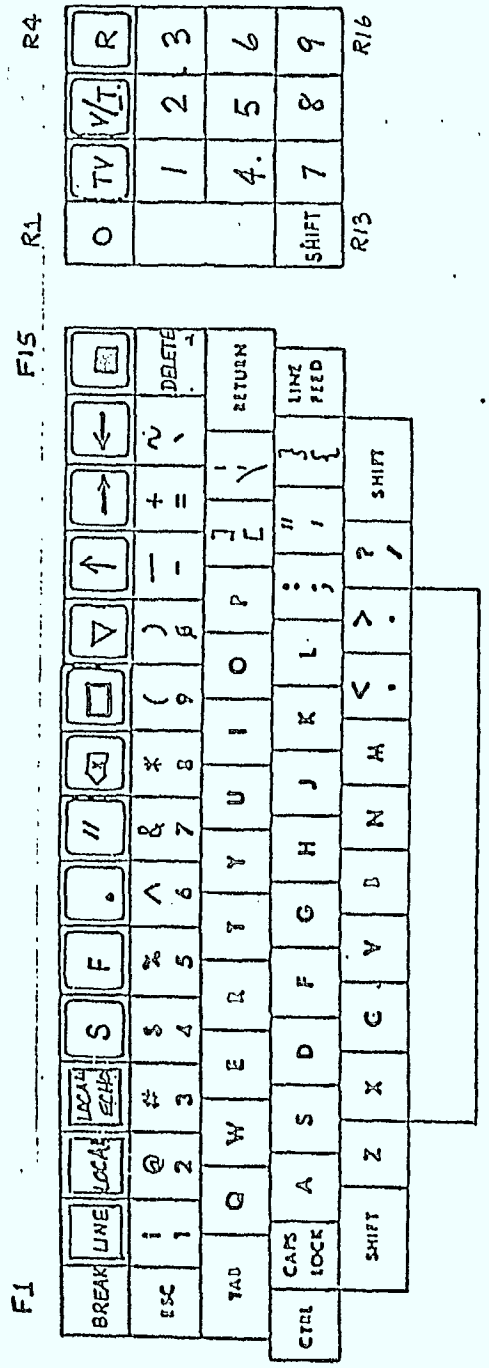
KEY	CODES Normal	Shift	Ctrl
1 !	31	21	31
2 @	32	40	32
3 #	33	23	33
4 $	34	24	34
5 %	35	25	35
6 ^	36	5E	36
7 &	37	26	37
8 *	38	2A	38
9 (	39	28	39
0)	30	29	30
- _	2D	5F	2D
` ~	60	7E	1E
= +	3D	2B	00
DELETE	7F	7F	1F
, <	2C	3C	2C
. >	2E	3E	2E
; :	3B	3A	3B
' "	27	22	27
/ ?	2F	3F	2F
{ }	7B	7D	1C
\ |	5C	7C	1B
[ ]	5B	7B	1D
RETURN	0D	0D	0D
LINE FEED	0A	0A	0A
SPACE	20	20	20
ESC	1B	1B	1B
TAB	09	09	09

Figure 3-2 KB5 key codes

KEY	CODES Normal	Shift	Ctrl
(F1)	E1	C1	E1
(F2)	E9	C9	E9
(F3)	F1	D1	F1
(F4)	F9	D9	F9
(F5)	F0	D0	F0
(F6)	E7	C7	E7
(F7)	F7	D7	F7
(F8)	E2	C2	E2
(F9)	FA	DA	FA
(F10)	EA	CA	EA
(F11)	F2	D2	F2
(F12)	F3	D3	F3
(F13)	EB	CB	EB
(F14)	E3	C3	E3
(F15)	FF	DF	FF
(R1)	EF	CF	EF
(R2)	E0	C0	E0
(R3)	E8	C8	E8
(R4)	F8	D8	F8
(R5)	-	-	-
(R6)	E4	C4	E4
(R7)	EC	CC	EC
(R8)	F4	D4	F4
(R9)	-	-	-
(R10)	E5	C5	E5
(R11)	ED	CD	ED
(R12)	F5	D5	F5
(R13)	same as SHIFT key		same as SHIFT key
(R14)	AD	BD	AD
(R15)	EE	CE	EE
(R16)	F6	D6	F6

Figure 3-2 KB5 key codes

Figure 3-3 KB5 Keyboard layout



KB5.0 Keyboard key-cap layout

It is desirable to maintain compatibility with units in the field. To accomplish this, the following code assignments are proposed:

a) ASCII remain unchanged
b) keypad codes remain unchanged
c) keypad codes be supplimented

These supplimentary codes take the form of ASCII characters with an added offset, i.e. a Telidon zero 0 would be an ASCII 0 plus an offset of $80 (0-$B0 = 0-$30 + $80).

This would be done for all keypad (Telidon) key codes; figure 3-4.

Implementation of this scheme on a standard alpha-numeric keyboard requires that the most significant data bit, bit 7, be set to zero for ASCII and to a one for Telidon. This could take the form of an alternate action key, similar to a CAPS LOCK, which would control bit 7 as well as forcing the upper case condition for the characters (S,F,R, etc).

Keycodes

KEYPAD

Symbol	Current Code (KeyPad To Term)	Character transmitted (Terminal to Host)	New code + $80 (Keypad To Term)
TV	E0		T - D4
V/T	E8		V - D6
S	F0	S - 53	S - D3
R	F8	R - 52	R - D2
"	E2	" - 22	" - A2
□	EA		C - C3
▽	F2		P - D0
⌫	FA		Del - FF (dup invalid ESC (9B))
1	E4	1 - 31	1 - B1
2	EC	2 - 32	2 - B2
3	F4	3 - 33	3 - B3
4	ES	4 - 34	4 - B4
5	ED	5 - 35	5 - B5
6	FS	6 - 36	6 - B6
7	E6	7 - 37	7 - B7
8	EE	8 - 38	8 - B8
9	F6	9 - 39	9 - B9
F	E7	F - 46	F - C6
O	EF	O - 30	O - B0
°	E7	. - 2E	. - AE
▦	FF	<CR>-0D	<CR> - 8D
←	E3	< - 3C	< - BC
→	EB	> - 3E	> - BE
↑	F3	- 5E	- D3 (prob. s/b $DE (^))

4.0 AUTO DIAL

Using the general Datacom split speed modem, model GDC-CDN-120/15, it is possible, using MK3 Telidon terminal, to automatically dial a user's telephone connection. There are however several areas which should be discussed.

a) modem hardware interface
b) storage of telephone numbers
c) method of calling up numbers and/or dial direct
d) user definition of numbers

At present the GDC modem has the capability of interfacing to the telephone line via what is known as the "programmable" connection.

This implies that a "data jack" must be installed at the user's site and an external data/talk switch must be used. Use of the data/talk switch defeats the purpose of auto dialing as the user is forced to manually intervene in the dialing process. A separate control of data mode, from the MK3 terminal, is required to eliminate the user intervention.

It should be noted that while the auto dial circuitry must be included on the modem, the technique of performing the dialing process is not an approved method. Any such connection, will be in violation of current telephone regulations.

The actual storage of the telephone numbers may be done in two manners:

a) in EPROM i.e. fixed numbers
b) in non-volatile, alterable storage

Storage of the numbers in EPROM is easily done at the time of manufacturing. The inclusion of a series of telephone numbers will permit the user to access a respective number of data bases.

Under certain circumstances, the pre-programmed telephone numbers may be restrictive in not allowing, the user access to all required data sources. The inclusion of a special command would allow the user to dial the telephone directly from the keypad using the digits available repertoire at present.

A third option possible for storing numbers is to utilize non-volatile storage.

This allows, either field programming of the numbers or, definition of the numbers by the user. To do this, the user must be provided with a method of defining and recalling the numbers. Hardware provisions must also be made in order to store the digits.

Two techniques are available for non-volatile storage:

a) battery backup RAM
b) non-volatile RAM

Non-volatile random access memories are currently available on the market. They do, however, require several voltages for operation and tend to be more expensive. (A single voltage 5 volt unit is available from MEM-EBAUCHES in Switzerland for $41).

An alternate method of storage is to use Cmos static random access memories with a battery for standby power, to retain the memory contents. This also requires a charging circuit to maintain the battery level.

To control the various dialing related functions on the MK3 terminal, several F sequence commands could be utilized:

1) F71.n to dial pre-defined number
2) F73.xxx to dial direct
3) F72.n to define telephone number
   (requires appropriate H/W).

5.0 ASCII TERMINAL

The objective is to provide a software package to emulate an 80 character video terminal using Norpak's alpha board.

Presently, there are numerous video terminals on the market; Volker Craig, Cybernex, Digital Equipment, Lear-Siegler, Hazeltime to name a few. What has been proposed by Electrohome is an emulation of a Lear-Siegler ADM3A terminal.

This suggested terminal implementation has two feature groups:

a) basic ASCII plus minimal editing
b) advanced editing functions

The first group includes:

i) alphabetic keys
ii) non-alphabetic keys
iii) cursor control
iv) minimal editing functions

All of the aforementioned functions are quite feasible to implement in the MK3 terminal.

There are additional or advanced editing functions presented in appendix C of Electrohome's statement of work. These functions are not overly complex, with the exception of two commands; transmit block and set transmit start. Both of these functions require more complex processing than the other commands. Additionally, there is a question of available program space within the MK3 terminal to implement all these commands.

After investigation into market conditions, Norpak is recommends that as an ASCII terminal, in the Canadian market a VT-100 emulation is preferred. The counter-part in the United States is either Hazeltine or Lear-Siegler.

In this regard, it is suggested that the MK III be configured to emulate a DEC VT-100 terminal with the omission of:

a) special graphics characters
b) VT52 compatibility
c) led indicators
d) majority of set-up functions (for VT100 H/W)

e) all DEC private codes

It should be noted that any ASCII terminal emulation will most likely require special keyboard keys to compliment it.

Whether the VT100 or Lear-Siegler type teminal emulation software will fit into the available memory space of the MK3 can only be determined after a careful study into the software. An alternate approach is to impliment a Volker-Craig VC404 terminal; which will fit in the eprom.

6.0 Summary

Hard copy Trendcom 100 printer:
- aspect ratio may not be acceptable
- print quality variation (i.e. density)
- monochrome only
- 240 dots horizontally
- special paper required

Key codes
- simple modification to alpha-numeric keyboards required
- compatibility maintain with existing systems

Auto dial
- regulatory approval questionable
- in present configuration, non-volatile ram is an expensive option

ASCII terminal
- Canadian market indicates VT-100 should be emulated
- eprom space may restrict code

7.0 Conclusions

Hard copy
- reconsider Trendcom 100 printer

Key codes
- impliment changes as indicated

Auto dial
- impliment using direct dial and pre-programmed numbers only

ASCII terminal
- impliment subset of VT-100 or full VC-404

8.0 Costing (Budgetary)

Item	Quantity	Cost
Hard copy interface	1K	$60
	10K / 100K	n/a
Note: suggest integrating into MK3		
Key codes (eprom code change only)	-	-
Auto dial (increased modem cost)	1K	$15
ASCII terminal (Alpha bd only)	1K	$80
	10K	$60
	100K	$40

APPENDIX A

TRENDCOM PRINTER

INTRODUCTION

Congratulations on your purchase of a Trendcom 100, the intelligent printer. Your new printer is a high-performance serial printer featuring 40 character-per-second printing with a full 96-character set. It is a true intelligent printer with full line buffering and bidirectional look-ahead printing. After one line has been printed left to right, the internal microprocessor examines the next line. It then moves the print head to the last character of the line to be printed and prints it right to left.

Large, legible characters are printed in a ten-character-per-inch format. The 7 dot print head provides clear readable copy on white thermal paper, available from Trendcom in 80 foot rolls.

The high reliability you can expect from the Trendcom 100 is derived from its mechanical simplicity. Two DC stepping motors provide control of the print head and the paper roller, the printer's only driven parts.

The Trendcom 100 is also simple to use. No external power supplies are needed, just plug it into the appropriate line voltage. Interfacing is also easy; the TTL-compatible input interfaces to the eight-bit parallel port on most microprocessors. In many cases, you'll be able to use an Interface Card from Trendcom. These are available—or will be soon—for the APPLE II, PET and TRS-80, as well as for RS232 serial.

The Trendcom 100 has two distinct operating modes: Text and Graphics. In the text mode, which is the default mode which the printer assumes when power is first applied, the printer utilizes the 96-character ASCII set shown in Table 1.

Table 1 HEX to ASCII Conversion

20	SP	38	8	50	P	68	h
21	!	39	9	51	Q	69	i
22	"	3A	:	52	R	6A	j
23	#	3B	;	53	S	6B	k
24	$	3C	<	54	T	6C	l
25	%	3D	=	55	U	6D	m
26	&	3E	>	56	V	6E	n
27	'	3F	?	57	W	6F	o
28	(	40	@	58	X	70	p
29	)	41	A	59	Y	71	q
2A	*	42	B	5A	Z	72	r
2B	+	43	C	5B	[	73	s
2C	,	44	D	5C	\	74	t
2D	-	45	E	5D	]	75	u
2E	.	46	F	5E	^	76	v
2F	/	47	G	5F	_	77	w
30	0	48	H	60	`	78	x
31	1	49	I	61	a	79	y
32	2	4A	J	62	b	7A	z
33	3	4B	K	63	c	7B	{
34	4	4C	L	64	d	7C	|
35	5	4D	M	65	e	7D	}
36	6	4E	N	66	f	7E	~
37	7	4F	O	67	g	7F	DEL

In the text mode, as each character is received it is first examined to see if it corresponds to the graphics control code, Hex 9E. If not, the most significant bit is "stripped" and the printer checks for the Carriage Return character, Hex 0D. With the exception of 0D, codes which are less than Hex 20 are ignored. Printable characters are stored in a buffer in the printer. The contents of the buffer will be printed following receipt of a Carriage Return code (0D) or upon receipt of the 41st character. The 41st character is stored in a temporary register and

the printer's Busy line goes high whenever the printer cannot accept data. Thus, as long as the hand-shaking protocols described under Interfacing are adhered to, no data will be lost even if the printer is sent lines longer than forty characters.

Sending the printer the graphics control code, Hex 9E, when it is in the text mode will cause it to enter the graphics mode. Any characters in the line buffer at that time will be lost. Thus, the 9E should normally be preceded by a Carriage Return (0D). Upon receipt of a 9E, the print head is returned to the left hand margin and the paper motor is advanced four steps (text is spaced six steps per line).

In the graphics mode, as each byte of data is received it is first examined to see if it corresponds to the text control character, Hex 9F. If not, the most significant bit is "stripped" and the remaining seven bits are used to directly control the print head, with the least significant bit corresponding to the bottom dot. A logical "1", +5 volts, causes the appropriate dot to be printed, while a logical "0", 0 volts, turns the dot off. In this mode, information is printed as it is received, with the first 240 bytes printed left to right, the next 240 printed right to left, etc.

In the normal graphics mode, therefore, it is necessary for the computer to present every other line "backwards". Also, when the printer is printing bidirectionally it is more difficult to maintain consistency of printing from line to line. Thus, on images with a lot of dark background, it is normal to see some horizontal "stripes" between alternate lines. Both of these characteristics can be avoided, at a sacrifice in total printing time, by running the printer unidirectionally.

As mentioned above, each graphics byte is checked for the text control character, Hex 9F. When a 9F is received, the print head is moved to the left hand margin, but no line feed occurs. Thus, by sending a 9F followed

by a 9E, the printer will exit the graphics mode, return to the left margin, do one graphics line feed, and re-enter the graphics mode prepared to print left to right. The 9F must, however, be sent before the 240th byte, otherwise the printer will have already reversed direction.

In the discussion above, we have assumed that the device driving the Trendcom 100 provides 8-bit data. In some systems, only seven bytes will be available, with the most significant bit unused. In this case, a pull-up resistor may be required to assure that the most significant bit remains high. (The most significant bit input could be grounded, but this would eliminate the graphics mode, since there would be no way for the printer to ever receive the graphics control code, Hex 9E.) When the most significant bit is high, the graphics control code becomes Hex 1E, and the text control code is 1F. Under these conditions, the software driving the printer must include a routine to prevent it from inadvertently sending a 1F. This would be accomplished by examining each byte just before it is sent to the printer and, if a 1F is found converting it to a 1B or 1E.

The printer uses a margin switch, activated by the print head, to maintain the left margin. In the graphics mode, the switch may cause an occasional one dot horizontal offset. Offsets which occur infrequently and are non-cumulative are normal.

APPENDIX B

ELECTROHOME PROPOSED TERMINAL

Minimum Required Terminal Features:

The notation ^<char> is used to indicate the ASCII code generated by holding down the control key while the <char> key is depressed. Some control characters such as ESC (^[) may require using both the control and shift keys. Appendix B is a list of all the commands, their assigned control characters, and equivalent letter codes. In the definitions which follow, only the letter code is given to avoid confusion.

Bell Subroutine (^G): This routine will ring the Mark III "bell" interface.

Cursor Controls: The following commands move the cursor about the screen. They are similar to the LSI ADM-3A. All cursor controls are nondestructive (i.e., they do not affect any of the data on the display).

Backspace (^H): Each time a backspace is executed, the cursor moves one position to the left. No cursor action should occur when the cursor is already in the leftmost column.

Linefeed (^J): Each time a line feed is executed the cursor moves down to the same position on the next line. If the cursor is already on the bottom line the top entire display will scroll up one line (losing the contents of the top line).

Upline (^K): Each time an upline is executed the cursor moves to the same character position in the line immediately above the current one. If the cursor is already on the top line there will be no display action.

Forespace (^L): Each time a forespace is executed the cursor moves to the next character position. If the cursor is on the last position on a line, no further advancement will ocurr.

Return (ΛM): This code moves the cursor to the first character position of the present line.

Home (ΛΛ): The cursor is moved to the upper left display position; line 1, column 1.

Load Cursor (Λ{, '=', <Y>, <X>): The next two characters following the Λ{, '=' sequence represent the absolute line and column (Y and X) coordinates which are used to position the cursor. The upper left cursor position is line 1, column 1. The characters required are calculated by adding 31 (decimal) to the desired line (or column) number. The Home Command is equivalent to the Load Cursor sequence Λ{, '=', SP, SP.

Editing Commands

The following commands are used to manipulate data on the screen. They will be output by the user program at any time. They are not executable from the keyboard.

Clear Screen (ΛZ): This deletes all data on the screen. The cursor position is not changed.

Line Delete (ΛU): The line containing the cursor is deleted. All lines below the cursor are moved up one line and a blank line is moved into the bottom line.

Erase To End Of Line From Cursor (Λ{L): The contents of the line between the current position of the cursor and the right hand screen boarder is erased, from the screen.

Erase To End Of Screen From Cursor (Λ{S): The contents of the display screen between the current position of the cursor and the last character position on the screen is erased.

Select Background Display (Λ[, ΛY): Display all following characters in inverse video (and/or blink as strapped in hardware).

Select Foreground Display (Λ[,Λ-). Display all following characters in normal video. (Default setting).

APPENDIX B

Control Codes

Code		ASCII	Function	FDX	Input HDX	BLK	Output
^@	00	NUL					
^A	01	SOH					
^B	02	STX	SETC: Set Configuration Switches	X	X	X	X
^C	03	ETX	ATTN: Return to Monitor	X	X	X	
^D	04	EOT	Transmit Block			X	
^E	05	ENQ	Auto Answer Back				X
^F	06	ACK					
^G	07	BEL	Bell Subroutine			X	X
^H	08	BS	Backspace			X	X
^I	09	HT	Horizontal Tab		X	X	X
^J	0A	LF	Line Feed		X	X	X
^K	0B	VT	Upline			X	X
^L	0C	FF	Forespace			X	X
^M	0D	CR	Carriage Return		X	X	X
^N	0E	SO	Unlock Keyboard			X	X
^O	0F	SI	Lock Keyboard			X	X
^P	10	DLE					
^Q	11	DC1	XON - Resume Output	X	X	X	
^R	12	DC2	Reserved				
^S	13	DC3	XOFF - Stop Output	X	X	X	
^T	14	DC4					
^U	15	NAK	Delete Line		X	X	X
^V	16	SYN	Insert Character			X	X
^W	17	ETB	Insert Line			X	X
^X	18	CAN	Delete Character			X	X
^Y	19	EM	Reserved				
^Z	1A	SUB	Clear Screen			X	X
^	1B	ESC	Escape Char for Multi Char Commands			X	X
^	1C	FS					
^	1D	GS					
^^	1E	RS	Home			X	X
^_	1F	US			X		
Ruboutf		DEL	Delete Character		X		

APPENDIX C

POSSIBLE EDITING FUNCTIONS

Char Insert (ΛV): The character indicated by the cursor and succeeding characters on the same line are shifted right one character. The cursor position is set to a blank This function will not operate if the last position on the line contains data.

Char Delete (ΛX): The character indicated by the cursor is removed. Characters to the right of the cursor on the same line are moved one position to the left.

Insert Mode (Λ[, 'I'): This command simplifies insertion of long strings of data. Logically precedes each succeeding character with an insert character command. The Insert Mode is terminated by any control character, which is otherwise ignored.
EX: ΛI FFFF =ΛvFΛvFΛvFΛvF

Transit Block (ΛD): Transit all screen data from the last transmit command (from line 1, column 1 if not on screen) up to the current cursor position, to the user program. Trailing blanks on each line (unless explicity entered by the user) are ignored. End of Text character (ΛD) is appended to the end of the transmission to signify end of text block. Protected fields are replaced by Horizontal Tabs (ΛI). No other control characters are transmitted.*

Set XMIT Start (Λ[, ΛD): Changes the cursor position associated with the last Transmit Block command to the current cursor position. This allows the user to select a command from a menu or repeatedly input the same string (as long as it stays on the screen).
*EX: AAA BBBB is transmitted as AAAAΛIΛIΛIΛI BBB
Background display = protected fieldΛI is only one character long.

Line Insert (ΛW): The line containing the cursor and all following lines move down one line. The bottom line on the screen is lost.

Form Feed (Λ⌈, ΛL): The form feed command sequence clears the screen and moves the cursor to the first position on the top line. This is a two character command because the FF character is used for the Forespace Command.

Vertical Tab (Λ⌈, ΛK): Each time a vertical tab is executed the cursor moves down to the next vertical tab stop. These stops are set every eight lines. If the next tab stop is off the bottom of the display, the screen will schroll up. This is a two character command because the VT character is used for the upline command.

Horizontal Tab (ΛI): Each time a horizontal tab is executed, the cursor moves right to the next tab stop. Tab stops are set at every eighth column. Cursor action when the next tab stop is beyond the right end will be that the cursor will go no further that the right hand side of the screen.

APPENDIX C

VT-100 TERMINAL

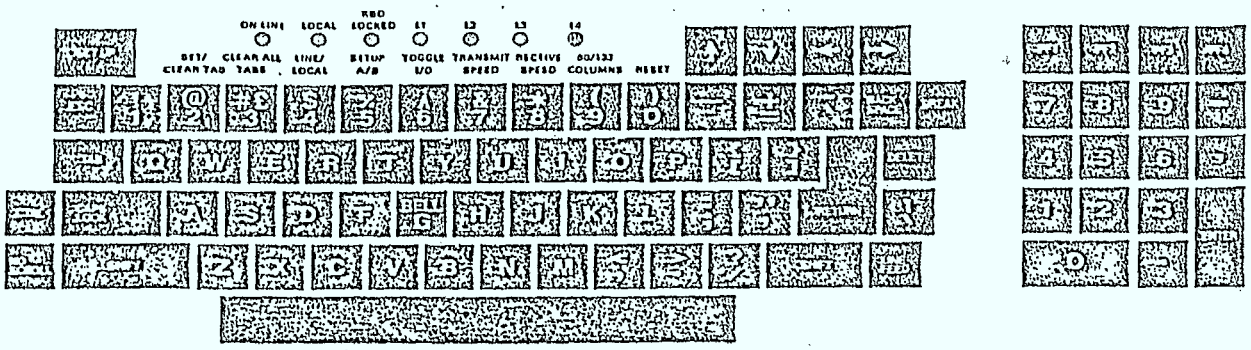


Figure 1-2 VT100 Keyboard

Table 3-2
Alphabetic Key Cod

Key	Uppercase Code (octal)	Lowercase Code (octal)	Key	Uppercase Code (octal)	Lowercase Code (octal)
A	101	141	N	116	156
B	102	142	O	117	157
C	103	143	P	120	160
D	104	144	Q	121	161
E	105	145	R	122	162
F	106	146	S	123	163
G	107	147	T	124	164
H	110	150	U	125	165
I	111	151	V	126	166
J	112	152	W	127	167
K	113	153	X	130	170
L	114	154	Y	131	171
M	115	155	Z	132	172

Table 3-3
Nonalphabetic Key Codes

Lowercase Character	Neither SHIFT Key Down (Octal)	Uppercase Character	Either or Both SHIFT Keys Down (Octal)
1	061	!	041
2	062	@	100
3	063	# or £	043
4	064	$	044
5	065	%	045
6	066	^	136
7	067	&	046
8	070	*	052
9	071	(	050
0	060	)	051
—	055	_	137
=	075	+	053
[	133	{	173
;	073	:	072
' (apostrophe)	047	"	042
, (comma)	054	<	074
. (period)	056	>	076
/	057	?	077
\	134	|	174
`	140	~	176
]	135	}	175

Control Character	Octal Code	Action Taken
NUL	000	Ignored on input (not stored in input buffer; see full duplex protocol).
ENQ	005	Transmit answerback message.
BEL	007	Sound bell tone from keyboard.
BS	010	Move the cursor to the left one character position, unless it is at the left margin, in which case no action occurs.
HT	011	Move the cursor to the next tab stop, or to the right margin if no further tab stops are present on the line.
LF	012	This code causes a line feed or a new line operation. (See new line mode.)
VT	013	Interpreted as LF.
FF	014	Interpreted as LF.
CR	015	Move cursor to left margin on the current line.
SO	016	Invoke G1 character set, as designated by SCS control sequence.
SI	017	Select G0 character set, as selected by ESC(sequence.
XON	021	Causes terminal to resume transmission.
XOFF	023	Causes terminal to stop transmitting all codes except XOFF and XON.
CAN	030	If sent during a control sequence, the sequence is immediately terminated and not executed. It also causes the error character to be displayed.
SUB	032	Interpreted as CAN.
ESC	033	Introduces a control sequence.
DEL	177	Ignored on input (not stored in input buffer).

Table 3-4
Function Key Codes

Key	Octal Value of Code Sent or Received by VT100	Action The Terminal Would Take if Host Sent That Code
RETURN*	015	Carriage return function
LINEFEED	012	Line Feed
BACKSPACE	010	Backspace function
TAB	011	Tab function
SPACE BAR	040	Deposit a space on the screen erasing what was there before.
ESC	033	The initial delimiter of an escape sequence – interpret the following character string from the host as a command, rather than displaying it.
DELETE	177	Ignored by the VT100

* The RETURN key can be redefined so that it issues 015_8, 012_8. (carriage return – line feed). The New Line feature in SET-UP mode provides this capability.

Table 3-5
Control Codes Generated

Key Pressed with CTRL key down (shifted or unshifted)	Octal Code Transmitted	Function Mnemonic	Key Pressed with CTRL key down (shifted or unshifted)	Octal Code Transmitted	Function Mnemonic
Space Bar	000	NUL	P	020	DLE
A	001	SOH	Q	021	DC1 or XON
B	002	STX	R	022	DC2
C	003	ETX	S	023	DC3 or XOFF
D	004	EOT	T	024	DC4
E	005	ENQ	U	025	NAK
F	006	ACK	V	026	SYN
G	007	BELL	W	027	ETB
H	010	BS	X	030	CAN
I	011	HT	Y	031	EM
J	012	LF	Z	032	SUB
K	013	VT	[	033	ESC
L	014	FF	\	034	FS
M	015	CR	]	035	GS
N	016	SO	~	036	RS
O	017	SI	?	037	US

Key	Keypad Numeric Mode	Keypad Application Mode	Key	Keypad Numeric Mode	Keypad Application Mode
0	0	ESC O p			ESC O m
1	1	ESC O q	, (comma)	, (comma)	ESC O l*
2	2	ESC O r	. (period)	. (period)	ESC O n
3	3	ESC O s	ENTER	Same as RETURN key	ESC O M
4	4	ESC O t			
5	5	ESC O u	PF1	ESC O P	ESC O P
6	6	ESC O v	PF2	ESC O Q	ESC O Q
7	7	ESC O w	PF3	ESC O R	ESC O R
8	8	ESC O x	PF4	ESC O S	ESC O S
9	9	ESC O y			

* The last character of the escape sequence is a lowercase L (154_8).

Table 3-8
ANSI Mode
Auxiliary Keypad Codes

NOTE
In ANSI mode, if the codes are echoed back to the VT100, or if the terminal is in local mode, the last character of the sequence will be displayed on the screen; e.g., PF1 will display a "P."

ANSI Compatible Mode

NOTE
Pn refers to a decimal parameter expressed as a string of ASCII digits. Multiple parameters are separated by the semicolon character (073_8). If a parameter is omitted or specified to be 0 the default parameter value is used. For the cursor movement commands, the default parameter value is 1.

Cursor Movement Commands

Cursor up	ESC [Pn A
Cursor down	ESC [Pn B
Cursor forward (right)	ESC [Pn C
Cursor backward (left)	ESC [Pn D
Direct cursor addressing	ESC [Pl; Pc H † or ESC [Pl; Pc f †
Index	ESC D
New line	ESC E
Reverse index	ESC M
Save cursor and attributes	ESC 7
Restore cursor and attributes	ESC 8

†Pl = line number; Pc = column number.

Erasing

From cursor to end of line	ESC [K or ESC [0 K
From beginning of line to cursor	ESC [1 K
Entire line containing cursor	ESC [2 K
From cursor to end of screen	ESC [J or ESC [0 J
From beginning of screen to cursor	ESC [1 J
Entire screen	ESC [2 J

APPENDIX B

GML Report

GML INFORMATION SERVICES

GML Corporation • 594 Marrett Road, Lexington, Massachusetts 02173 • (617) 861-0515

March 4, 1981

Mr. Pat Anthony
ELECTROHOME ELECTRONICS
809 Wellington Street North
Kitchener, Ontario N2G 4J6
CANADA

Dear Mr. Anthony:

Follow-up research on your RS232-C connector question indicates all the companies surveyed configure pin 2 as "transmit" and pin 3 as "receive" as defined by the Electronics Industry Association, 2001 Eye Street N.W., Washington, D.C. 20006, USA, (202) 457-4900. This finding was confirmed by gentlemen at AMP and AMPHENOL Corporations, two of the largest American connector manufacturers.

If you have future questions, please give us a call.

Sincerely,
GML Corporation

P. Kenealy

Patrick Kenealy
Senior Technical Editor

P.S. Please note we have found that Datapoint Corporation usually uses 50 pin RS232-B connectors (not indicated in 2/26/81 letter) but will adapt to RS232-C as required.

GML INFORMATION SERVICES

GML Corporation • 594 Marrett Road, Lexington, Massachusetts 02173 • (617) 861-0515

February 26, 1981

Ms. Agnes Mohr
ELECTROHOME ELECTRONICS
809 Wellington Street North
Kitchener, Ontario N2G 4J6
CANADA

Dear Ms. Mohr:

Our research indicates all the companies below which are marked with a "Y" manufacture their RS232 terminals with a female connector built in to accept male, 25-pin type D connectors. Those companies marked with an "*" were contacted by telephone but have not contacted us. We will call you if any of them tell us that their terminals have plugs unlike those marked "Y".

Y	(1)	ADDS
Y	(2)	ANN ARBOR
Y	(3)	BEEHIVE
*	(4)	ITT COURRIER
Y	(5)	DATAMEDIA
Y	(6)	DATAPOINT
Y	(7)	DIGITAL EQUIPMENT
Y	(8)	GENERAL TERMINAL (Infoton)
Y	(9)	HARRIS
Y	(10)	HAZELTINE
Y	(11)	HEWLETT-PACKARD
*	(12)	HONEYWELL
Y	(13)	INTERTEC DATA
Y	(14)	LEAR SIEGLER
Y	(15)	MICROTERM
*	(16)	RAYTHEON
*	(17)	SPERRY UNIVAC
Y	(18)	TELETYPE
Y	(19)	TELEVIDEO
*	(20)	TELEX

GML INFORMATION SERVICES

GML Corporation • 594 Marrett Road, Lexington, Massachusetts 02173 • (617) 861-0515

February 19, 1981

Ms. Agnes Mohr
ELECTROHOME ELECTRONICS
809 Wellington Street North
Kitchener, Ontario N2G 4J6
CANADA

Dear Ms. Mohr:

Enclosed is the source data for your RS232 display terminal data search. RS232C terminals are offered by 169 companies world-wide. 475 current displays offer RS232-capability as a standard feature; 38 offer RS232 as an extra cost option. We estimate that the following companies account for over 85% of all installed RS232 display terminals:

1. ADDS
2. ANN ARBOR
3. BEEHIVE
4. ITT COURRIER
5. DATAMEDIA
6. DATAPOINT
7. DIGITAL EQUIPMENT
8. GENERAL TERMINAL (Infoton)
9. HARRIS
10. HAZELTINE
11. HEWLETT-PACKARD
12. HONEYWELL
13. INTERTEC DATA
14. LEAR SIEGLER
15. MICROTERM
16. RAYTHEON
17. SPERRY UNIVAC
18. TELETYPE
19. TELEVIDEO
20. TELEX

If you have any question about our work so far or if you need further data for your product planning, please contact me directly.

I wish your new product luck and look forward to serving Electrohome in the future.

Sincerely,
GML Corporation

Patrick Kenealy
Senior Technical Editor

PK:sd

Enc.

RS232 COMPATIBLE TERMINALS

ADDS	CONSUL 920
ADDS	CONSUL 980
ADDS	CONSUL 980A
ADDS	CONSUL 980B
ADDS	REGENT 20
ADDS	REGENT 25
ADDS	REGENT 25/P
ADDS	REGENT 25/120
ADDS	REGENT 25/1500
ADDS	REGENT 30
ADDS	REGENT 40
ADDS	REGENT 60
ADI	D60
ADI	D60S
ADI	LIGHT 50
ADVANCED ELECTRONIC	AED512
ALPHAVERTER	SERIES 400
AMPEX	DIALOGUE 80
ANDERSON JACOBSON	AJ 510
ANN ARBOR TERMINALS	ADM3A-COMPAT
ANN ARBOR TERMINALS	VT52-COMPAT/S
ANN ARBOR TERMINALS	1680-COMPAT
ANN ARBOR TERMINALS	400S
ANN ARBOR TERMINALS	4080-COMPAT
ANN ARBOR TERMINALS	5315
ANN ARBOR TERMINALS	5080-COMPAT
APPLIED SYSTEMS	ASC TERMINAL
ARTS ASSOCIATES	LPVT
AUTO-TROL	CC-80
AWA (AUSTRALASIA)	VTE-6
AYDIN CONTROLS	5215
AYDIN CONTROLS	5216
AYDIN CONTROLS	5217
AZURDATA	SCOREPAD
AZURDATA	SCOREPAD LC
AZURDATA	SCOREPAK
BEEHIVE	B550
BEEHIVE	MD35
BEEHIVE	MICRO BEE DM1A
BEEHIVE	MICRO BEE DM1S
BEEHIVE	MICRO BEE DM10
BEEHIVE	MICRO BEE DM20
BEEHIVE	MICRO BEE DM30
BEEHIVE	MICRO 4400
BUNKER RAMO	SYSTEM 90
BUNKER RAMO	SYSTEM 90/22
BUNKER RAMO	SYSTEM 90/32
BUNKER RAMO	2204
BUNKER RAMO	2206
BUNKER RAMO	2210
BUNKER RAMO	2212
BURNT HILL	BH720
BURR-BROWN	TM25
C ITOH	VIT 100
CARTERFONE	ADM-3A
CARTERFONE	7100
CARTERFONE	7830
CHROMATICS	CG-1398
CHROMATICS	CG-1399
CHROMATICS	CG-1598
CHROMATICS	CG-1998

CHROMATICS	CG-3990A
CHROMATICS	CG-5309
CIFER SYSTEMS	CUB
CIFER SYSTEMS	2604
CIFER SYSTEMS	2605
CIFER SYSTEMS	2632
CIFER SYSTEMS	2684
CMC MARKETING	TEI PT208
CODEX	CDX-68
COMARK	OB-11-12
COMPUTEK	ECONOTEXT
COMPUTEK	ECONOTYPE
COMPUTEK	200/10
COMPUTEK	200/20
COMPUTEK	200/40
COMPUTEK	216/30
COMPUTER OPERATIONS	4000 SERIES
COMPUTERWISE	RM-I
COMPUTERWISE	TRANSACTOR I
COMPUTERWISE	TRANSACTOR II
COMPUTERWISE	TRANSACTOR III
CONTROL CONCEPTS	FM-3275
CONTROL DATA	PLATO
CONTROL DATA	751
CONTROL DATA	752
CONTROL DATA	756
CONTROL DATA	92451
CONTROL DATA	92452
CONTROL DATA	92456
CUSTOM TERMINALS	TR-B
CUSTOM TERMINALS	TR-10
CUSTOM TERMINALS	TR-80
CYBERNEX	APL-100
CYBERNEX	LGR-1
CYBERNEX	LGR-2
CYBERNEX	MDL-100
CYBERNEX	MDL-110
CYBERNEX	MDL-120
CYBERNEX	MDL-125
CYBERNEX	MDL-404
CYBERNEX	MDL-452
CYBERNEX	MDL-5120
CYBERNEX	MDL-52
CYBERNEX	MDL-6053
DACOLL ENGINEERING	DL180 VDT
DACOLL ENGINEERING	241
DACOLL ENGINEERING	242-1
DACOLL ENGINEERING	242-2
DACOLL ENGINEERING	242-3
DACOLL ENGINEERING	246
DACOLL ENGINEERING	247
DATA GENERAL	DASHER D100
DATA GENERAL	DASHER D2(6052)
DATA GENERAL	DASHER D2(6053)
DATA GENERAL	DASHER D200
DATA GENERAL	DASHER D3(6093)
DATA GENERAL	DASHER D4(6124)
DATA GENERAL	DASHER D5
DATA TERM & COMM	382
DATAGRAPHIX	132-1
DATAGRAPHIX	132-1D
DATAGRAPHIX	132-70
DATAGRAPHIX	132A
DATAGRAPHIX	132B
DATAMEDIA	ELITE 1521A

DATAMEDIA	ELITE 3025A
DATAMEDIA	ELITE 3045A
DATAMEDIA	ELITE 3052A
DATAMEDIA	ELITE 4000A
DATAPOINT	3600
DATAPOINT	3610
DATAPOINT	3670
DATAPOINT	8200
DATAVIEW	MONARCH-52
DELTA DATA SYSTEMS	2830
DELTA DATA SYSTEMS	4000
DELTA DATA SYSTEMS	7100
DELTA DATA SYSTEMS	7300
DELTA DATA SYSTEMS	7500
DIGI-LOG SYSTEMS	TELECOM II
DIGITAL	PDT-11/110
DIGITAL	PDT-11/130
DIGITAL	VT100
DIGITAL	VT100-T
DIGITAL	VT103
DIGITAL	VT11-A
DIGITAL	VT72/T
DIGITRONICS	ALPHA-VERTER
DIGITRONICS	431
DIRECT	VP 800/A
DIRECT	VP800/B
DIRECT	900
DMC	DMC 720
DOCUMATION	5030
DREXELBROOK	TRU-VIEW
DTI DATA TERMINALS	DG-6053
DTI DATA TERMINALS	DTI E-52
DTI DATA TERMINALS	ENTRY 81
ECD	SMART ASCII
ECS MICROSYSTEMS	4000
ECS MICROSYSTEMS	4500
EECO	D300
EECO	D400 POLLING
EECO	EDITOR I
ELECTROMAGNETIC SCI	HHT 101
ENGINEERING MICRO	DATAMYTE 1000
ENGINEERING MICRO	DATAMYTE 900
GDS DATA SYSTEMS	DISPLAYMASTER
GENERAL TERMINAL	100E
GENERAL TERMINAL	GT-101
GENERAL TERMINAL	200/1
GENERAL TERMINAL	200/3
GENERAL TERMINAL	200/4
GENERAL TERMINAL	GT-400
GENISCO COMPUTERS	G-1000
GR ELECTRONICS	POCKET TERMINAL
HARRIS	8180
HARRIS	8210
HARRIS	8220
HARRIS	8680
HARRIS	8770
HARRIS	9200
HAZELTINE	EXECUTIVE 80-20
HAZELTINE	EXECUTIVE 80-30
HAZELTINE	MOD ONE/EDIT
HAZELTINE	MOD ONE/POLLING
HAZELTINE	1410
HAZELTINE	1420
HAZELTINE	1421
HAZELTINE	1500
HAZELTINE	1510

HAZELTINE	1520
HAZELTINE	1552
HEWLETT-PACKARD	2621A
HEWLETT-PACKARD	2621P
HEWLETT-PACKARD	2626A
HEWLETT-PACKARD	2640B
HEWLETT-PACKARD	2640C
HEWLETT-PACKARD	2640N
HEWLETT-PACKARD	2640S
HEWLETT-PACKARD	2641A
HEWLETT-PACKARD	2645A
HEWLETT-PACKARD	2645K
HEWLETT-PACKARD	2645N
HEWLETT-PACKARD	2645S
HEWLETT-PACKARD	2647A
HEWLETT-PACKARD	2648A
HEWLETT-PACKARD	2649A
HEWLETT-PACKARD	3071A
HEWLETT-PACKARD	3075A
HITACHI	H-7000
HONEYWELL	FDC3102
HONEYWELL	FDC3106
HONEYWELL	FDC3305
HONEYWELL	SDE-3102
HONEYWELL	SDE-3106
HONEYWELL	SDE-3301
HONEYWELL	SDE-3305
HONEYWELL	SPD 20/20 TPU
HONEYWELL	SPD 20/30 TPU
HONEYWELL	SPD 20/40 TPU
HONEYWELL	SPD 320 LFC
HONEYWELL	SPD 325
HONEYWELL	SPD 330/2
HONEYWELL	SPD 820/2
HONEYWELL	VIP 7100
HONEYWELL	VIP 7105
HONEYWELL	VIP 7200
HONEYWELL	VIP 7205
HONEYWELL	VIP 7700
HONEYWELL	VIP 7700R
HONEYWELL	VIP 7705R
HONEYWELL	VIP 7760
HONEYWELL	VIP 7801
HONEYWELL	VIP 7802
HONEYWELL	VTS 7740
HONEYWELL	VTS7710
HONEYWELL	1501 VDU
HUMAN DESIGNED	CONCEPT APL
HUMAN DESIGNED	CONCEPT APL 4
HUMAN DESIGNED	CONCEPT 104
IBM	3101
ICL	1500
IDEOGRAPHIX	IPX 5460
IESI	DATACORDER I
IESI	DATACORDER II
IMLAC	DYNAGRAPH 3205
IMLAC	PDS-4/L
IMLAC	PDS-4/S
IMLAC	6210
IMLAC	6220
INDUSTRIAL DATA	IDT-900
INFORMATION INT'L	3300
INFORMATION PRODUCT	GRAPHIC 8
INFORMER	D304
INFORMER	D311
INFORMER	D321

INTEGRATED DATA SYS	ID-400
INTELLIGENT SYSTEMS	3601
INTELLIGENT SYSTEMS	3621
INTELLIGENT SYSTEMS	8001
INTELLIGENT SYSTEMS	8001G
INTELLIGENT SYSTEMS	8001H
INTELLIGENT SYSTEMS	8013
INTELLIGENT SYSTEMS	8031
INTELLIGENT SYSTEMS	8051
INTELLIGENT SYSTEMS	8070
INTELLIGENT SYSTEMS	8071
INTERFACE TECH	736
INTERTEC DATA	COMPUSTAR
INTERTEC DATA	EMULATOR
INTERTEC DATA	INTERTUBE II
INTERTEC DATA	SUPERBRAIN
LEAR SIEGLER	ADM-3A
LEAR SIEGLER	ADM-31
LEAR SIEGLER	ADM-42
LOGICON-INTERCOMP	EE/80
MAGNAVOX	ORION-60/S1
MAGNAVOX	ORION-60/S3
MAGNAVOX	ORION-60/S4
MBB	GRAPHIC 7
MEGADATA	MAC-NET
MEGADATA	MC77
MEGADATA	SIGNATURE
MEGADATA	2001
MEGADATA	700
MEGATEK	WHIZZARD 5000
MEGATEK	WHIZZARD 7000
MEGATEK	5014
MICON INDUSTRIES	MICET
MICRO DIVERSIONS	GIFTED TERMINAL
MICRO DIVERSIONS	MICROANGELO
MICRO DIVERSIONS	WORDSMITH
MICRO-TERM	ACT-IA
MICRO-TERM	ACT-IVA
MICRO-TERM	ACT-5A
MICRO-TERM	MIME-100
MICRO-TERM	MIME-2A
MICRO-TERM	MIME-314
MICROCOSMIC SYSTEMS	DATACORDER I
MICRODATA	PRISM
MICROPAD	MICROPAD
MILTOPE	MIL-TERM-2000
MOHAWK DATA SCI	21/20
MOHAWK DATA SCI	21/40
MOHAWK DATA SCI	21/50
MOTOROLA MICROSYS	EXORTERM 150
MSI DATA	MSI 88/D
MSI DATA	MSI 88/E
MSI DATA	MSI 88/F
NATIONAL CSS	VISTA 80
NCR	7900 MOD 1
NCR	796-301
NCR	796-401
NCR	796-501
NIXDORF	LK 3000
NOLTON	KUSTOM ACT 10
NORPAK	MVP
NORSK DATA	NCT
NORSK DATA	ND 224X
NORSK DATA	ND 226E
NORSK DATA	ND 227X

NORTHERN TELECOM	DATA 100/77
NORTHERN TELECOM	DATA 100/78
NORTHERN TELECOM	DATA 100/82
NORTHERN TELECOM	NTSC 405
NORTHERN TELECOM	NTSC 440
NORTHERN TELECOM	NTSC 445
NORTHERN TELECOM	SYCOR 255
NORTHERN TELECOM	SYCOR 290
OLIVETTI	TC800
OMNI COMPUTER	OMNITERMINAL
ONTEL	OP-1/R, RS
ONTEL	OP-1/15
ONTEL	OP-1/50
ONTEL	OP-164
OTTO ELECTRONICS	OE 1000
PARADYNE	7801
PERKIN-ELMER	BANTAM 550
PERKIN-ELMER	SUPER OWL 1250
PERKIN-ELMER	SUPER OWL 1251
PERKIN-ELMER	3500
PERRY DATA SYSTEMS	PDS9800
PHONE 1	P1-11
PHONE 1	P1-14
PLESSEY PERIPHERALS	PT-100
PORTABLE MICROSYST.	PDS 65
PRIME COMPUTER	EXTENDED VIDEO
PRIME COMPUTER	STANDARD VIDEO
PRIME	PT-25
PRIME	PT-45
PRINCETON	8500M
PROBLEM SOLVER SYS	TLC
PRONTO ELECTRONIC	601A
QUALTERM	QD-100
QUOTRON SYSTEMS	800
RACAL-MILGO	40+ KL1
RACAL-MILGO	400/1
RACAL-MILGO	4278
RAMTEK	FS-2500
RAMTEK	RM-3000 IDS
RAMTEK	RM-9000 SERIES
RAMTEK	6114
RAMTEK	6200A
RAMTEK	8120
RAMTEK	8410
RAYTHEON	PTS 100
RCA	COLOR TERMINAL
RCA	CRT TERMINAL
RCA	DATASPEED 40/3
RCA	ZMS-50
ROCKWELL INTERNAT'L	3010
SANDERS ASSOCIATES	GRAPHIC 7
SANDERS ASSOCIATES	GRAPHIC 8
SCI SYSTEMS	2404
SKS	DE 10
SKS	DE 100
SOROC TECHNOLOGY	IQ 120
SOROC TECHNOLOGY	IQ 120-C
SOROC TECHNOLOGY	IQ 140
SOUTHWEST DATA SYS	SDS X 720
SOUTHWEST TECH	CT-82
SPERRY UNIVAC	UDS 2000
SPERRY UNIVAC	UNISCOPE 200
SPERRY UNIVAC	UTS 20
SPERRY UNIVAC	UTS 40
SPERRY UNIVAC	UTS 400

SPERRY UNIVAC	UTS 400 TE
SRA COMMUNICATIONS	SEMIGRAF 240
SSTI	DT/C 8200
SSTI	SERIES 8100
STERIA	MECURE-S
STERIA	MERCURE-D
SUMMAGRAPHICS	GM ONE
SYSTEMATICS GENERAL	T5101
SYSTEMATICS GENERAL	T5145
SYSTEMATICS GENERAL	T5153
SYSTEMS RESEARCH	SRJ/OP1-R
TANDBERG (NORWAY)	TDV 2114
TANDBERG (NORWAY)	TDV 2115
TANDBERG (NORWAY)	TDV 2116
TANDBERG (NORWAY)	TDV 2200
TANDEM COMPUTERS	6520
TANO	OUTPOST 11
TANO	OUTPOST 11
TEC	1401
TEC	1440
TEC	1445
TEC	2401
TEC	2402
TEC	420
TEC	425
TEC	430
TEC	435
TEC	450
TEC	455
TEC	460
TEC	465
TEC	510
TEC	571,671
TEC	70
TEKTRONIX	4006-1
TEKTRONIX	4010-1
TEKTRONIX	4012
TEKTRONIX	4013
TEKTRONIX	4014-1
TEKTRONIX	4015-1
TEKTRONIX	4016-1
TEKTRONIX	4023
TEKTRONIX	4024
TEKTRONIX	4025
TEKTRONIX	4027
TEKTRONIX	4052
TEKTRONIX	4054
TEKTRONIX	4081
TELCON INDUSTRIES	AMBASSADOR I
TELCON INDUSTRIES	AMBASSADOR II
TELCON INDUSTRIES	VCS-100
TELCON INDUSTRIES	VCS-300
TELECRAFTERS	MCD 4001B
TELERAM	MKII 2277
TELERAM	P-1888
TELERAM	PORTABUBBLE/81
TELERAY (RESEARCH)	10M
TELERAY (RESEARCH)	11
TELERAY (RESEARCH)	12
TELETYPE	40/1
TELETYPE	40/2 KDP
TELETYPE	40/3
TELETYPE	40/4
TELETYPE	4540
TELEVIDEO	TVI-912B,C
TELEVIDEO	TVI 920

TELEVIDEO	950
TELEX	TC275B
TELEX	TC276
TELEX	TC277
TELEX	310
TERAK	8510/A
TERAK	8530
TERMIFLEX	HT/10
TERMIFLEX	HT/10
TERMIFLEX	HT/11
TERMIFLEX	HT/12
TERMIFLEX	HT/2
TERMIFLEX	HT/3
TERMIFLEX	HT/4
TERMIFLEX	HT/6
TERMIFLEX	HT/7
TERMIFLEX	HT/8
TERMINAL DATA	675
TERMINAL DISPLAY	ENVOY E20
TEXAS INSTRUMENTS	770/1
TEXAS INSTRUMENTS	770/2
TEXAS INSTRUMENTS	771/1
TRANSAC	ALPHA 10
TRANSAC	ALPHA 20
TRANSAC	VMP 70
TRANSAC	VMP 77
TRIVEX	+70 (0712)
TRIVEX	+70 (0722)
TRIVEX	+70 (0752)
TYMSHARE	420
TYMSHARE	430
UTEC	DATA-KINETIC
VECTOR AUTOMATION	GRAPHICUS 80
VIDEO DATA SYSTEMS	MPC-2000
VIDEO DATA SYSTEMS	100 SERIES
VIDEOTON	VDDS
VISUAL TECHNOLOGY	VISUAL 200
VOLKER-CRAIG	VC404
VOLKER-CRAIG	VC410
VOLKER-CRAIG	VC414H
VOLKER-CRAIG	VC415APL
VOLKER-CRAIG	VC4152
WANG LABORATORIES	PCS II
WANG LABORATORIES	WCS-15
WANG LABORATORIES	2236
WENGER DATENTECHNIK	DATAPAD ZE 661
WESTINGHOUSE CANADA	1625
WESTINGHOUSE CANADA	1640
WORDPLEX	WORDPLEX/1
XEROX	1330
ZENTEC	ZEPHYR
ZENTEC	ZMS-40
ZENTEC	ZMS-50
ZENTEC	ZMS-70
ZENTEC	ZMS-90

TELEVIDEO	950
TELEX	TC275B
TELEX	TC276
TELEX	TC277
TELEX	310
TERAK	8510/A
TERAK	8530
TERMIFLEX	HT/10
TERMIFLEX	HT/10
TERMIFLEX	HT/11
TERMIFLEX	HT/12
TERMIFLEX	HT/2
TERMIFLEX	HT/3
TERMIFLEX	HT/4
TERMIFLEX	HT/6
TERMIFLEX	HT/7
TERMIFLEX	HT/8
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TERMINAL DISPLAY	ENVOY E20
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TEXAS INSTRUMENTS	770/2
TEXAS INSTRUMENTS	771/1
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TRANSAC	ALPHA 20
TRANSAC	VMP 70
TRANSAC	VMP 77
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TRIVEX	+70 (0722)
TRIVEX	+70 (0752)
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VECTOR AUTOMATION	GRAPHICUS 80
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VOLKER-CRAIG	VC414H
VOLKER-CRAIG	VC415APL
VOLKER-CRAIG	VC4152
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WANG LABORATORIES	WCS-15
WANG LABORATORIES	2236
WENGER DATENTECHNIK	DATAPAD ZE 561
WESTINGHOUSE CANADA	1625
WESTINGHOUSE CANADA	1640
WORDPLEX	WORDPLEX/1
XEROX	1330
ZENTEC	ZEPHYR
ZENTEC	ZMS-40
ZENTEC	ZMS-50
ZENTEC	ZMS-70
ZENTEC	ZMS-90

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APPENDIX C

Group Delay Study

FINAL REPORT
ON
GROUP DELAY CHARACTERISTICS
IN
TELIDON RECEIVERS

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May 9, 1980

ABSTRACT

This report is a study of RF-IF demodulator characteristics in standard TV receivers, and how they may be adapted to teletext requirements.

In addition, various solutions for improvement of these characteristics in the C46 TV receiver are discussed with respect to teletext applications.

The report is a result of study under contract with the Department of Communications, Communications Research Centre, whose assistance is gratefully acknowledged.

CONTENTS

1.0 Introduction

2.0 RF-IF Teletext Specifications

3.0 The Standard TV Receiver

4.1 SAW Filters

4.2 Triple Transit Echos

5.0 Demodulator Types

6.0 The C-46 TV Receiver

7.0 Improvement of Group Delay

8.0 Synchronous Demodulators

9.0 Cost Estimation

Appendix: List of References

1.0 INTRODUCTION

Teletext uses the television broadcast signal to carry information. Teletext signals do not interfere with the transmission of normal TV programming. Spare horizontal lines in the vertical blanking interval are used to carry this extra information. An NRZ (non-return to zero) digital data signal is inserted into these horizontal lines.

Performance of the standard television receiver is not always sufficient for teletext data reception. To optimize the reception of digital data, closer attention should be paid to the IF amplifier and video detector. If the performance of these circuits is not satisfactory, the decoder cannot produce error-free display information.

An IF amplifier and video detector designed for good TV pictures does not necessarily provide good performance for teletext reception. The required response for the video signal is a complex subject, but the most critical parameters are amplitude, and group delay characteristic versus frequency.

In order to obtain good picture quality, amplitude is of prime importance. Bandwidth design for good picture quality will probably leave adequate amplitude performance for

teletext. Response should be flat over the video bandwidth of 3.58 MHz. This is satisfactory for teletext reception, because teletext components above 3.58 MHz are of less significance.

The problem is that good amplitude frequency response will not give error-free teletext reception if the phase characteristic is not good enough. Signals passing through the IF amplifier and video detector are delayed; this is specified as a group delay. The absolute value of the group delay is not important if it is constant over the required bandwidth. This means that the phase characteristic is linear. Non-linearities in phase will result in varying group delay, degrading the teletext data.

In addition to the magnitude of the variations, their characteristics with frequency can be important for error-free performance. Distortion, at low frequencies of the video spectrum, produce considerably more errors than distortion at higher frequencies.

Experience shows that if group delay varies not more than ± 50 μsecs through the video frequency range, there is little dependance on the shape of the characteristics.

Group delay variations may produce more errors if the signal is too week or the amplitude characteristic is not satisfactorily flat.

Our idealy distortionless system requires that all frequency components by equally delayed and all frequency amplitudes be modified by the same factor. This means that the amplitude characteristic must be flat and group delay must be as near zero as possible.

The transfer function of a distortionless system would be:

$$H(\omega) = A \ell^{-j\omega td}$$

and group delay:

$$t_d = -\frac{d\phi}{dt}$$

where A is amplitude of the signal

t_d is group delay

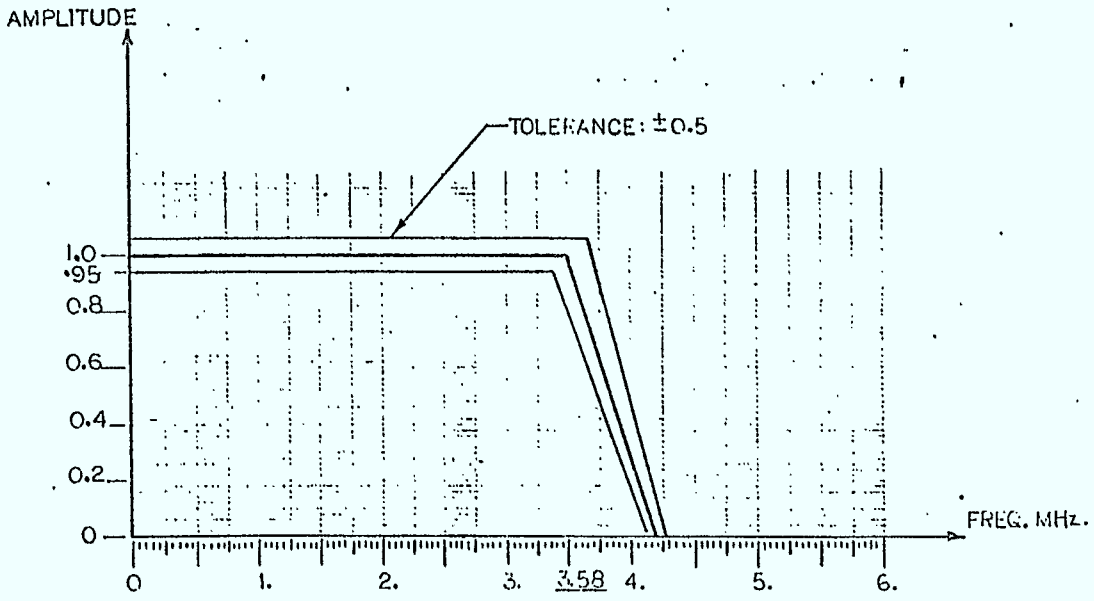
ϕ is phase

A and t_d are constant for the distortionless system.

2.0 RF-IF TELETEXT SPECIFICATION

In the practical system some distortion is inevitable and the minimum performance specification for the transfer function of the RF-IF system must therefore be recognized.

The RF-IF system specifications for modifying the C-46 T.V. receiver to receive teletext follow:



AMPLITUDE – FREQUENCY RESPONSE

Frequency response, from the R.F. to the video output of the teletext signal shall be:

- 0 db ± 0.5 dB from D.C. to 3.5 MHz
- sharp drop from 3.5 MHz to equal -40 dB at 4.2 MHz

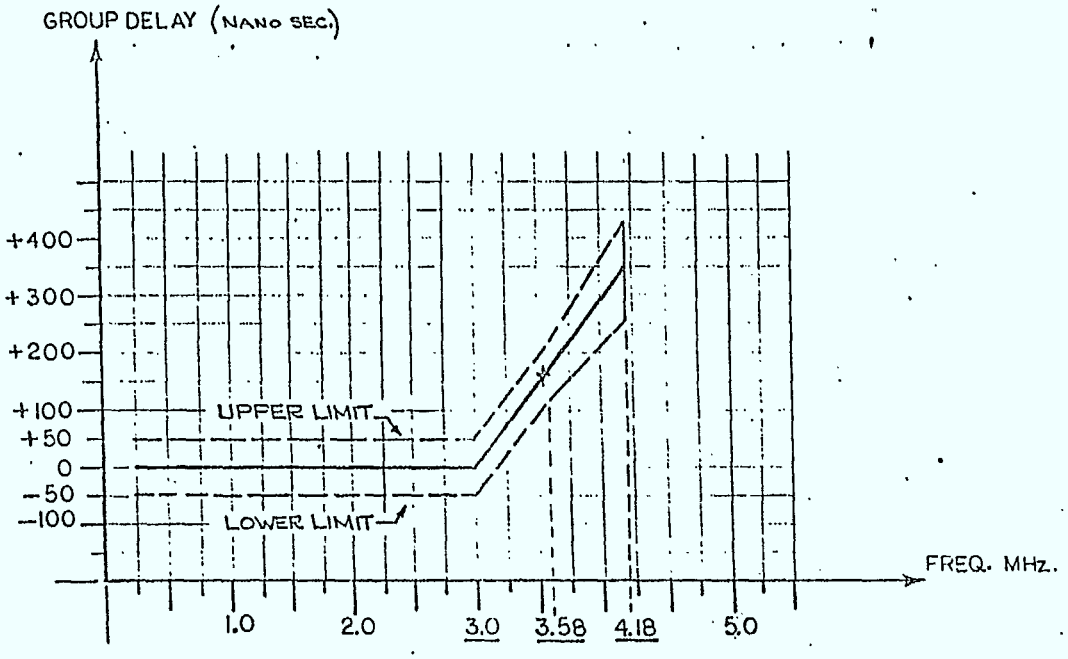
These specifications are for amplitude vs. modulating frequency response.

Group delay response:

- zero from 0.2 MHz to 3 MHz
- linearly increasing from 3.0 to 4.18 MHz as to equal + 170 usec at 3.58 MHz.

Tolerances shall be:

- better than ± 50 usec from 0.2 MHz to 3.58 MHz
- increase linearly to ± 80 usec at 4.18 MHz



GROUP DELAY RESPONSE

These requirements are close to the minimum performance characteristics for television broadcast demodulators, which are specified by standard RS-462.

3.0 STANDARD TV RECEIVERS

The asymetric (vestigial) sideband nature of the television broadcast system results in loss of one side-band, except in the region of 0.75 MHz.

An ideal receiver usually is considered to be one which provides complementary response to lower and upper side-bands within the ± 0.75 MHz double side-band region (Nyguist slope). The overall transmission gain through the double and single sided region is, therefore, constant. This means that the amplitude characteristic vs. the modulating frequency is flat.

The IF selectivity of the standard TV receiver and required specifications are different at the 3.58 side-band. In TV receivers, the IF reduces the 3.58 MHz colour subcarrier by 6 dB relative to the mid-band frequencies. This reduction causes less quadrature distortion in the signal. The chrominance circuit peaks the video signal.

From these requirements, the amplitude response vs. sideband frequencies of TV receiver demodulators have a typical "haystack" frequency response.

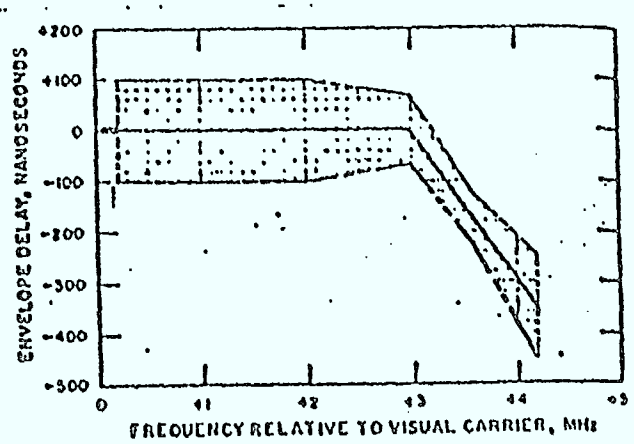
The "haystack" response in home TV receivers helps to reduce group delay distortion in the higher frequency region.

Group delay is frequency dependant within the intended passband, because of the inherent phase non-linearity of networks used to shape amplitude vs. frequency response of the receiver. This means the design of bandpass filter and the sound-notch filter can introduce distortion.

Recently, Surface Acoustic Wave (SAW) filters, have been used to reduce group delay distortion substantially.

With a good design it is not difficult to reduce group delay distortion to ± 50 nsec in the frequency range from 0.2 MHz to 3 MHz.

The standard broadcast signal has a group-delay pre-distortion at higher frequencies as shown in the following graph:



Group delay pre-distortion is -170 nsec for the frequency 3.58 MHz.

If group delay characteristic of the demodulator is that of required teletext standard (+170 nsec at 3.58 MHz) the overall response will give relatively zero group delay up to 4.2 MHz.

In home TV receivers RF-IF group delay response through the chrominance frequency region usually does not compliment the transmitter pre-distortion. The group delay complement is provided by the sum of group delay corrections of the RF-IF and the chrominance demodulator. As a result, the overall phase characteristic, in the chrominance frequency range, can be linear. Output from the RF-IF demodulator of a TV receiver has a different group delay vs. frequency response curve than that which teletext reception requires.

Of numerous functions required by the IF amplifier in a colour TV receiver, selectivity is the most difficult to achieve. Requirements call for placement of several frequencies with close tolerance within the bandpass, while simultaneously attempting to reject frequencies extremely close to the edges of the desired bandpass.

In conventional designs, the required selectivity is obtained in the IF amplifier. Tuner circuits and sigle-stage transistor amplifiers are interspersed. The tuned circuits provide the selectivity and simultaneously increase the gain of the amplifiers by tuning out the transistors capacitances, the amplifiers decouple the tuned circuits from each other, thereby facilitating the design of the filter.

The filter has a large relative bandwidth to pass the desired T.V. channel, but it needs steep slopes in order to attenuate the adjacent channels. Large attenuation is particularly required at the few specific frequencies where interference occurs.

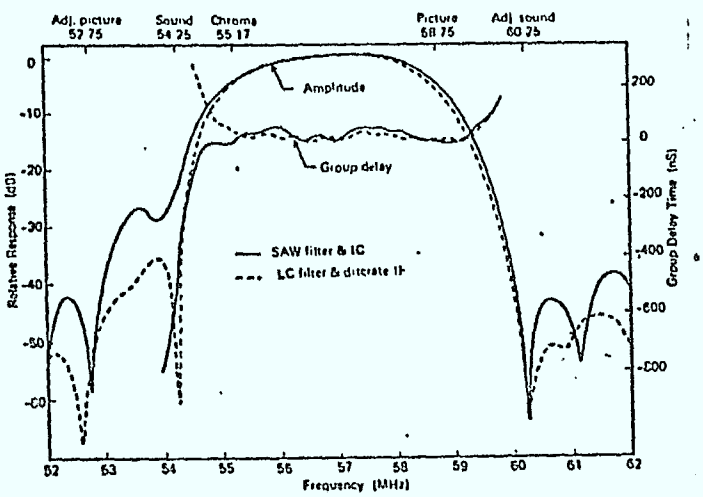
With a good design, however, all the required characteristics can be achieved with conventional I.F. filtering.

4.1 SAW FILTERS

Recently, Surface Acoustic Wave Filters (S.A.W.) have appeared as an attractive alternative in designing T.V. receiver I.F. stations. The S.A.W. filter is a desirable colour T.V. receiver component and can be considered for use in home colour T.V. design.

Saw filters are small and can easily be mass produced. The required frequency response, including deep traps to suppress adjacent carriers, is easily obtained. Good transient response is an inherent characteristic. Production does not need tuning of the I.F. amplifier. Amplitude vs. frequency response and the Group Delay Characteristics can be modeled independantly.

Characteristics of conventional and SAW filters are compared in the following graph:



4.2 TRIPLE TRANSIT ECHOS

One of the inherent problems with SAW filters is group delay ripple, which can cause transmission distortion. This has been designated as "Triple Transit Echo", (TTE). These echos result from part of main signal being reflected from the output to the input, then back to the output of the device. This signal, therefore, makes triple transition through the filter as opposed to the main signal, which makes but one transition.

A simplified relationship between echos and ripples in group delay response can be represented by the equation:

$$\text{ECHO LEVEL} = \frac{\text{P-P Group Delay Ripple}}{2T}$$

where T is the ripple rate in μsec (cycles/MHz)

Group delay ripple rejection is then:

$$20 \log \frac{\text{P-P Group Delay Ripple}}{2T} \text{ (dB)}$$

The impedance matching circuits are needed in both input and output to achieve the specified TTE impression.

5.0 TYPES OF DEMODULATORS

The asymetric (vestigial) side-band nature of the receiver broadcast system results in loss of one side (except of up to 0.75 MHz).

A commonly used envelope demodulator introduces quadrature distortion due to the single side-band nature of the singal at higher frequency ranges.

Quadrature distortion derives its name from the quadrature-phase signal component, which results from the loss of one side-band.

The output of the demodulator has a signal:

$$f(t) = p(t)\ \cos\omega t + q(t)\ \sin\omega t$$

where $p(t)$ is in-phase component

$q(t)$ is quadrature component

and then:

$$\text{amplitude } A = \sqrt{p(t)^2 + q(t)^2}$$

$$\text{phase } \phi(t) = \text{arc tg } \frac{g(t)}{p(t)}$$

The term $\phi(t)$ represents the phase modulation due to the quadrature component.

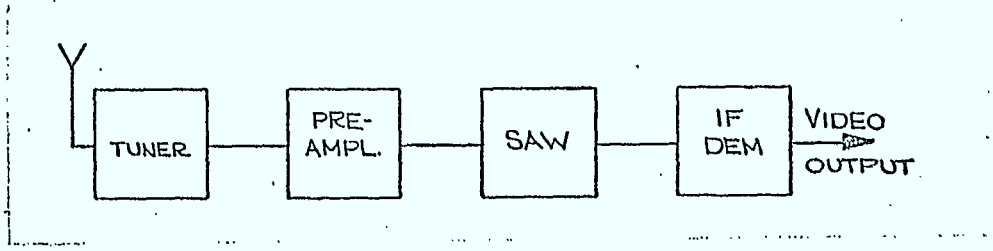
The synchroneous demodulator with a phase-stable reference signal gives only the desired in-phase component.

Two types of synchroneous demodulators are currently being used. Both are multiplier low-level demodulators.

In one case the reference signal is derived from the incoming signal by filtering and limiting. The reference signal tracks the incoming carrier phase. As far as carrier phase modulation is concerned, the signal is much like that from envelope demodulation.

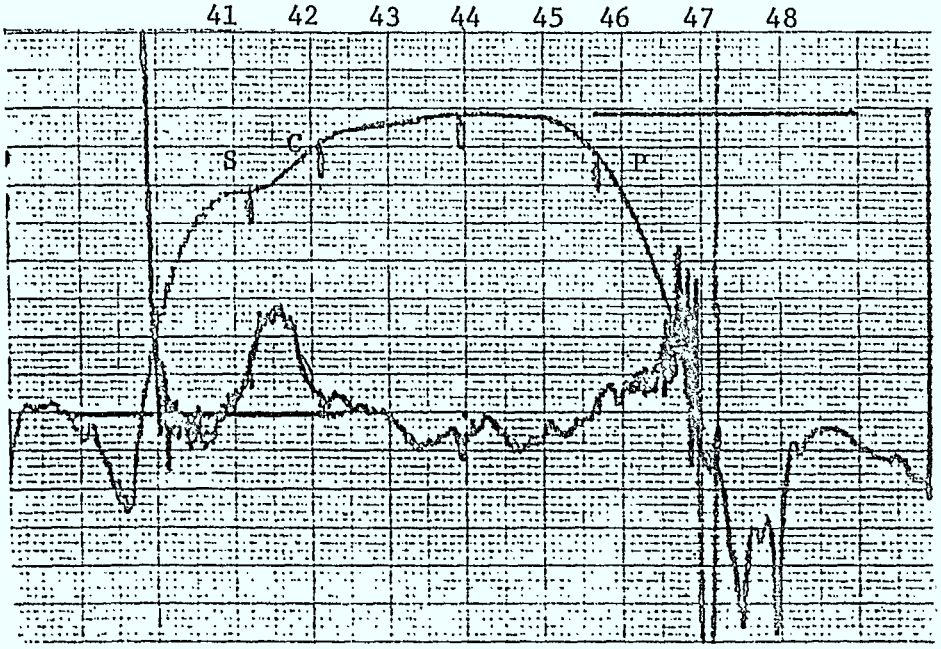
In the P.L.L. type the reference signal is derived from the oscilator, which is phased-locked to the incoming carrier.

6.0 C46 TV RECEIVER



The IF preamplifier is arranged in front of SAW filter in order to cover the insertion loss of the SAW filter and to match the input impedance of the SAW filter. The preamplifier is tuned to 44 MHz.

The SAW filter is a low cost surface acoustic wave component with characteristics suitable for the standard TV receiver requirements. Characteristics of SAW filter are shown on the picture:



H: 1 MHZ/DIV.

V: 10 dB/DIV.

or

100 ns/DIV.

The transmission gain has a frequency response typical for the standard TV receiver. Picture carrier level and the chroma subcarrier level are just equal 6 dB lower than middle band frequencies. The sound level is 12 dB down to prevent cross modulation in the following IF amplifier stages.

The carrier frequencies of the adjacent channels are attenuated to sufficient levels.

SAW filter specification

Center Frequency	44 MHz
Max. Input	5 V P-P
Triple Transit Supression	-43 dB
Insertion Loss (Max.)	-18 dB
Operation Temperature	$-20^{\circ}C + 70^{\circ}C$
Spurious	Under -29 dB, from 24.75 thru 63.75 MHz
Bandwidth	-4 dB ± 1.9 dB at 42.17 and 45.75 MHz
Input Impedance	3.8 KΩ 13.5 pf at 44 MHz
Output Impedance	3.2 KΩ 11 pf at 44 MHz

A low noise one chip colour TV IF amplifier and low level synchroneous detector is used in C46 design.

A synchroneous detection system, in which the IF signal to be detected is a multiplier where the reference signal is extracted from the IF signal by a tuned circuit, which reduces the amount of chroma-sound crossbeat (920 kHz).

The circuit consists of T104 and R121 on the schematic diagram. If this circuit is designed to have high sensitivity the output stage IF filter and the sound carrier trap can be eliminated.

C46 IF design has some filtering with small contribution to the overall IF characteristics and, therefore, all consideration can be concentrated on SAW filter characteristics.

7.0 IMPROVEMENT OF THE GROUP DELAY CHARACTERISTIC

Our intention was to find out what the possibilities were to utilize standard TV receiver circuits for teletext reception. The following information is based on Electrohome's C-46 television receiver.

The video signal carrying the teletext information into the decoder is obtained from the RF+IF circuits, which are a part of the basic TV receiver.

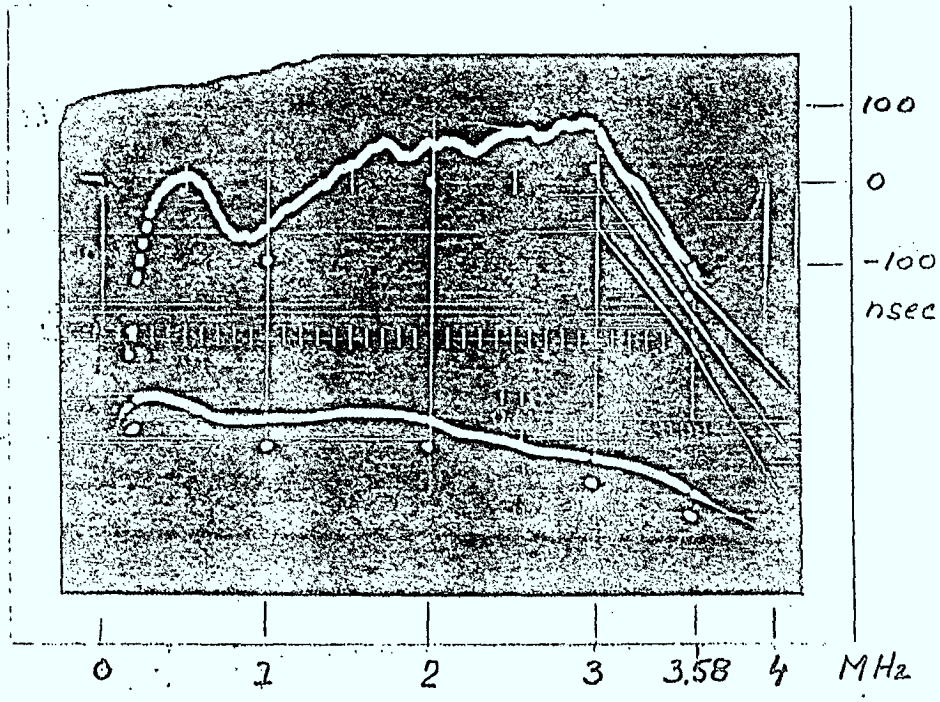
An additional video output is available for the teletext decoder.

The C46 demodulator characteristics were already described in the previous sections.

The first approach, for improvement of teletext performance is to check if each production TV set is tuned for the optimal IF characteristics.

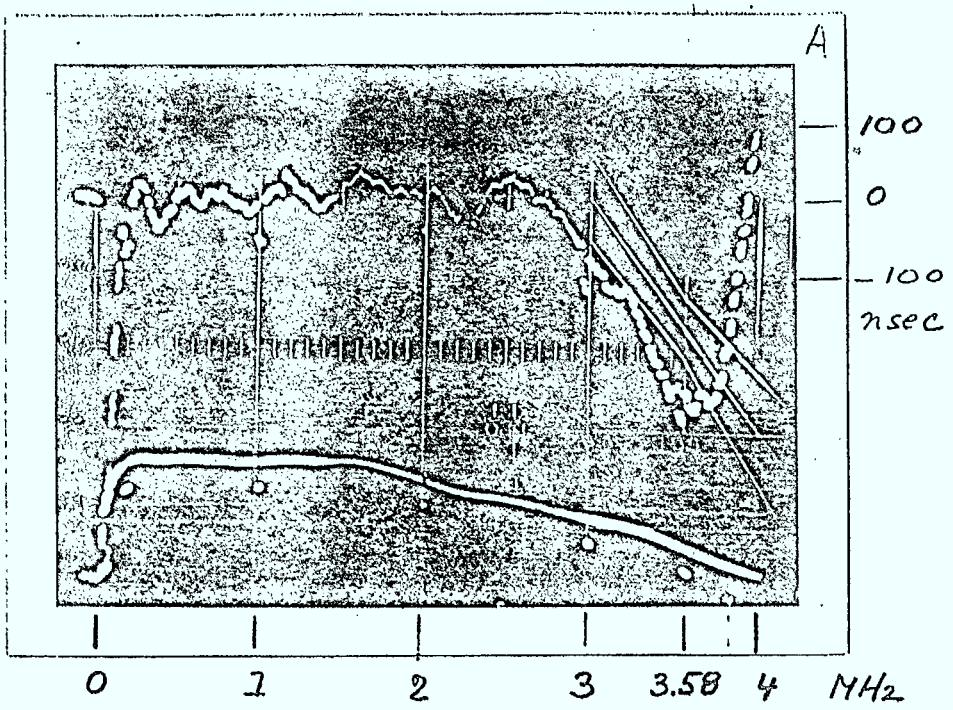
During the TV chassis production, routine alignment procedures are used to obtain the best overall performance, for best picture specifications. The group delay characteristics are not monitored or checked.

A number of production TV chassis were tested during this study and it was found that none of them had the IF tuned for optimal group delay characteristics. Typical waveforms are shown below:



As seen above, group delay is distorted in the low frequency video region, the most critical region for the teletext reception. The value of ripple is up to 250 μsec P-P, and character of this distortion gives very unsatisfactory group delay ripple rejection.

It is possible to improve the group delay characteristic by some additional tuning during the assembly of Telidon TV receivers for the optimal IF characteristics. The following picture shows the resulting improvement:



The group delay characteristic is flat ± 80 µsec within the frequency region of 0.2 - 3 MHz.

This procedure requires that group delay test equipment be available to the production line along with additional labour. The estimated cost is outlined later in this report.

The amplitude and group delay characteristics at higher video frequencies cannot be sufficiently aligned to meet the required specifications, however, even improvement of the low frequency region by additional alignment can be valuable for teletext reception.

To meet the required specifications for amlitude and group delay over the entire video spectrum, some correction has to be performed at higher frequencies.

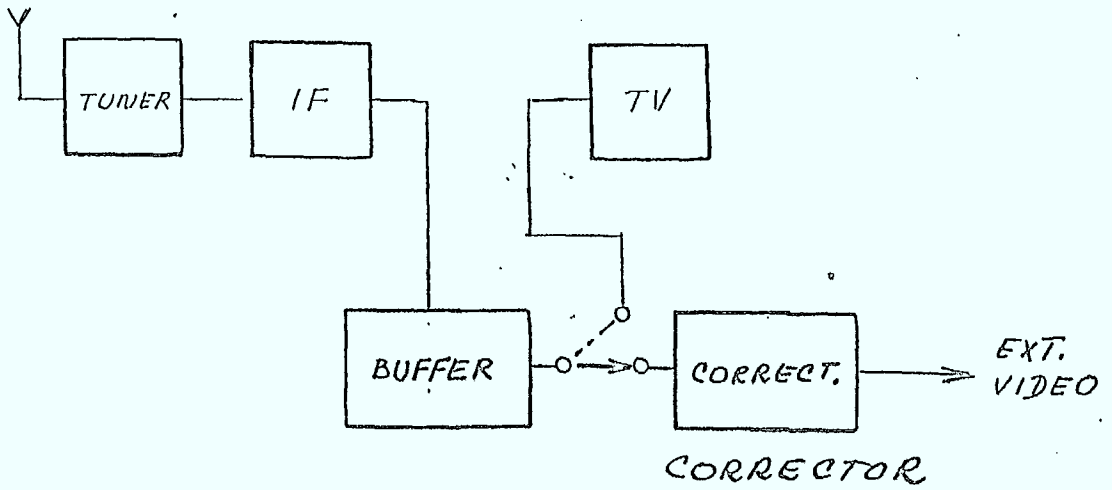
The C46 TV receiver-monitor is provided with an external composite video signal which is derived from a TV demodulator and connected to the BNC connector via a buffer circuit. The proposed idea is to add a corrector to this buffer circuit.

This correction will not affect the television's performance.

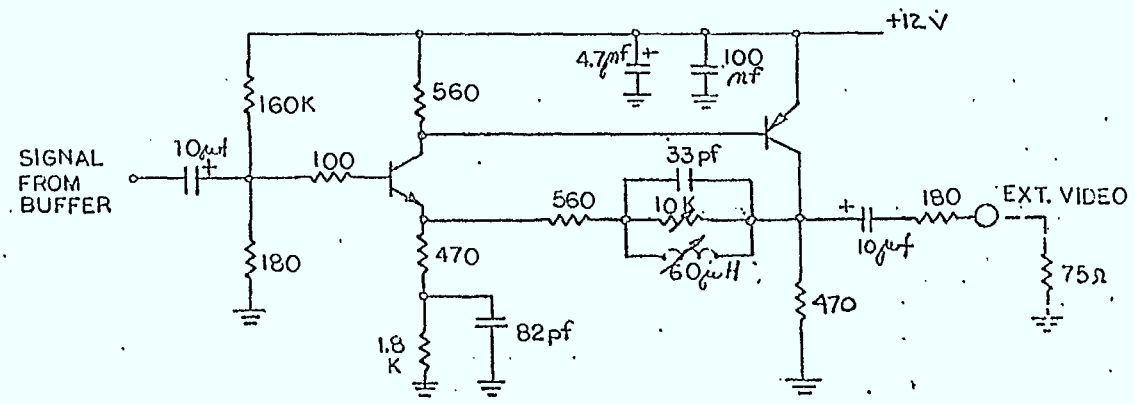
A simple corrector was developed and added to the television sample, which is being delivered as required in the contract.

Circuit description:

Block diagram of the connection with the corrector follows:



and the circuit diagram:



Basically, the circuit is a tuned bandpass filter, with the transfer characteristic:

$$H(S) = \frac{1 + \delta_1 S + aS^2}{1 + \delta_2 S + aS^2}$$

The amplitude versus frequency equation:

$$H(\omega) = \sqrt{\frac{(1-(\frac{\omega}{\omega o})^2)^2+\omega^2\delta_1^2}{(1-(\frac{\omega}{\omega o})^2)^2+\omega^2\delta_2^2}}$$

and group delay response:

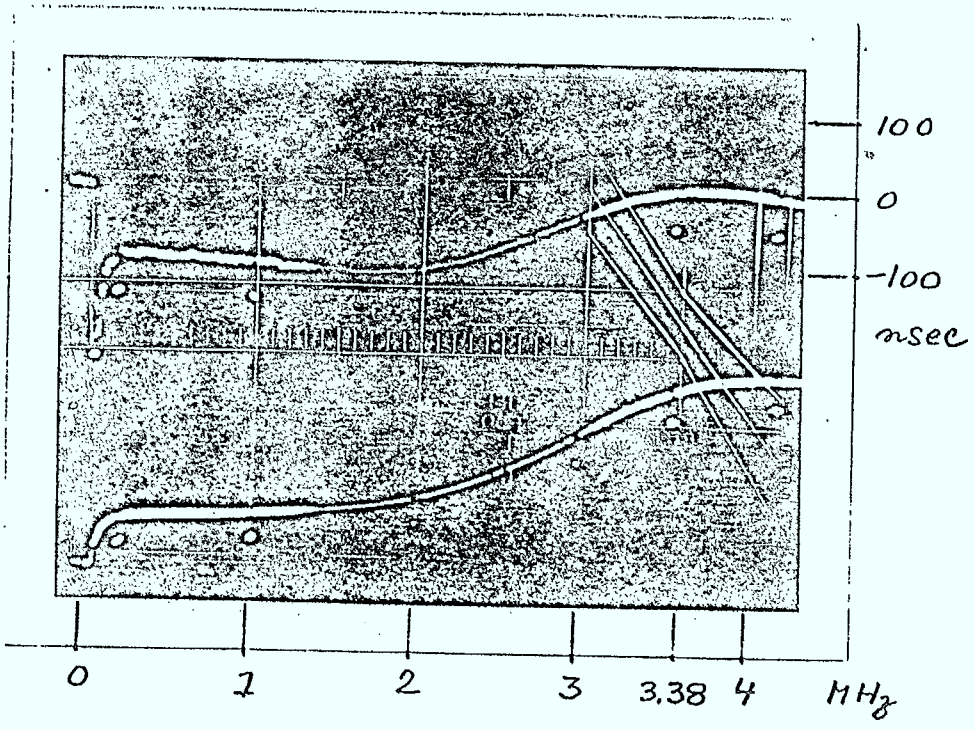
$$D = -(\delta_1-\delta_2)\frac{(1+(\frac{\omega}{\omega o})^2)\left[(1-(\frac{\omega}{\omega o})^2)^2-\delta_1\delta_2\omega^2\right]}{\left[(1-(\frac{\omega}{\omega o})^2)^2+\omega^2\delta_1^2\right]\left[(1-(\frac{\omega}{\omega o})^2)^2+\omega^2\delta^2{}_2\right]}$$

where ωo - center frequency

δ_1 δ_2 - peaking constants

$$\delta_2 = \frac{2\xi}{\omega o}$$

ξ = dumping factor of the filter



The center frequency ώo can be adjusted with the 60 µH coil shown in the schematic diagram and is tuned between 3.5 MHz and 4 MHz.

Peaking of the amplitude and group delay can be adjusted with the variable 10K resistor (in parallel with the 60 µH coil).

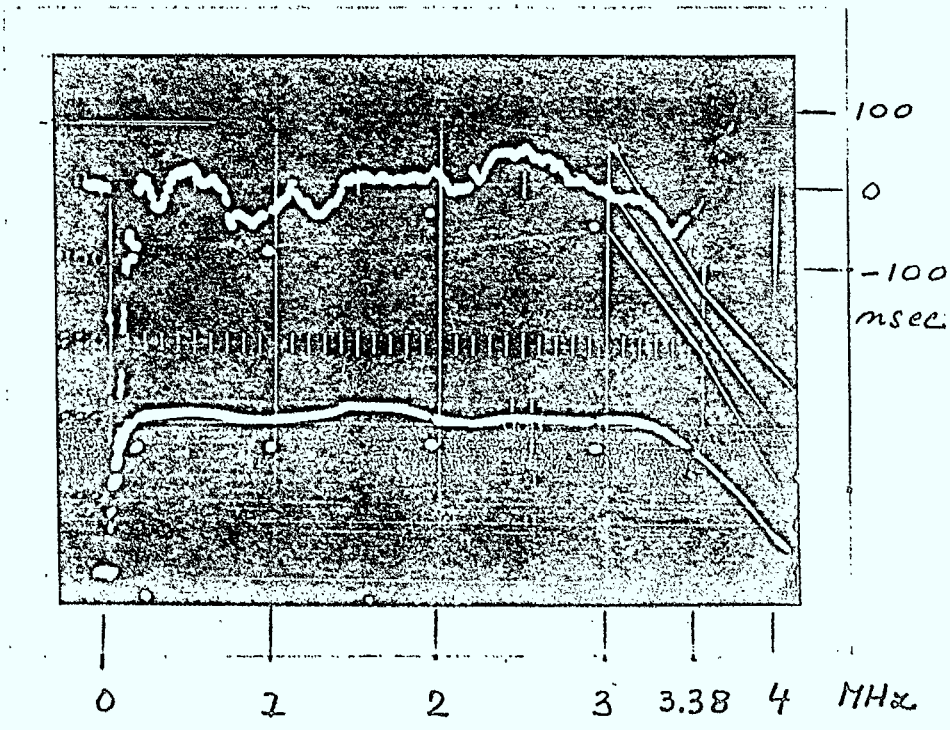
The 82 pf capacitor, in parallel with the 1K8 resistor, improves the shape of the amplitude characteristics.

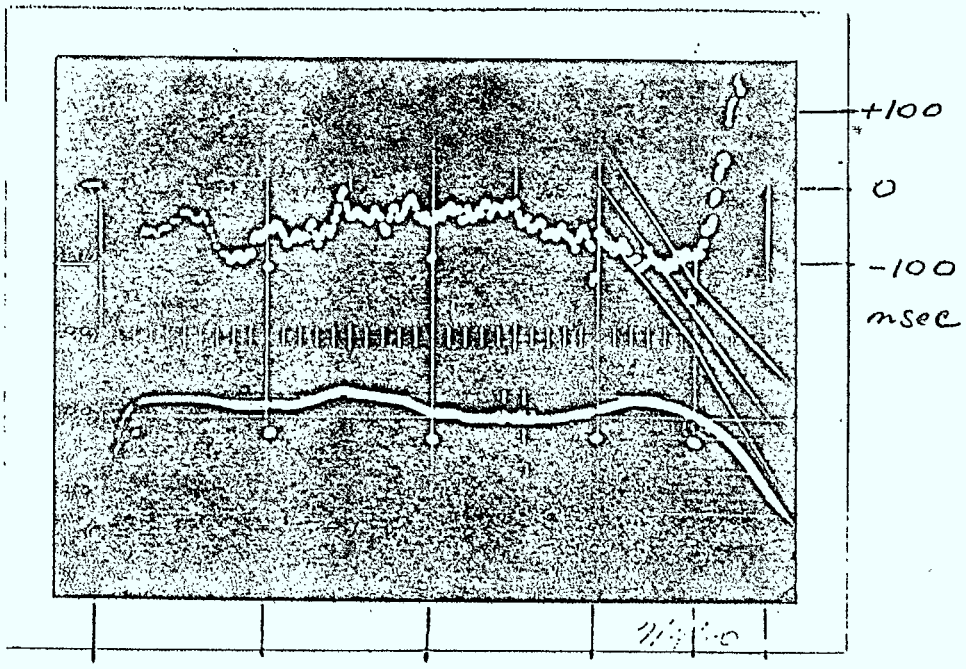
If the TV IF demodulator is aligned properly, these two variables, in continuation with sound rejection filter (on PIF), are suffidient to adjust the required characteristics of the group delay above 3.58 MHz.

Because a tuned filter is used to correct the required characteristics, some ringing can be expected during the pulse transmission. This parameter is specified as the K-factor, if measured using the 2T sine-squared pulse method. K was measured at less than 1.2% on the modified C46 TV set. For the standard broadcast demodulator, RS 462 has a K of 1/2% maximum.

Note: Group delay at the frequency of 4 MHz cannot be corrected by this simple corrector.

The following pictures show modified amplitude and group delay characteristics measured on different TV sets.




+100
0
-100
msec

8.0 SYNCHRONOUS DEMODULATORS

The synchronous demodulator exhibited improved frequency response and group delay characteristics when compared to envelope detectors. Operating characteristics allow for more accurate restoration of the digital data for teletext reception, therefore, the synchronous demodulator is recommended for this application.

Recently synchronous demodulators were used in standard TV receivers because they provided simpler, more economical, IF amplifier circuitry with better performance.

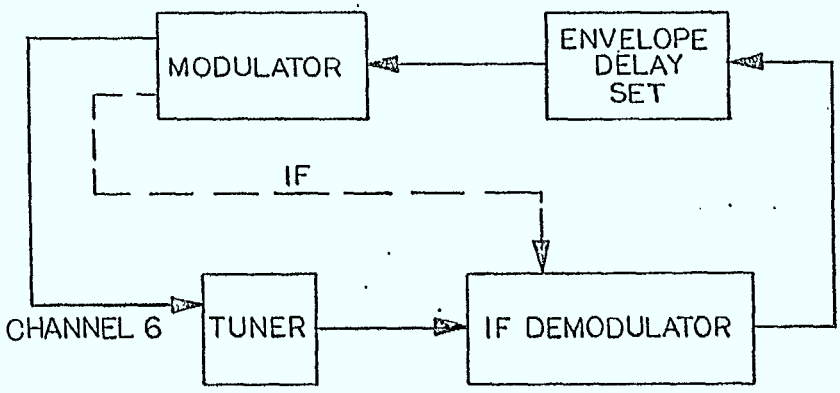
As indicated above, two types of synchronous demodulators are being used currently. Both types are fully suitable for teletext reception.

The phase-locked loop type is considered better for noise rejection, because the reference carrier frequency has higher spectral purity. On the other hand, it is more difficult to hold the carrier frequency precisely in phase.

Amplitude and Group Delay Test Procedure

Connection:

CONNECTION:



Equipment:

Envelope delay measuring set (CRC property) Shibasoku Model 201/1.

Commander modulator (Electrohome property) Jerrold Model CCM-C.

Note: Modulator accepts video signal and provides group delay pre-distortion to meet standard FCC pre-distortion requirement.

9.0 ESTIMATED COST PER TV SET TO IMPROVE IF CHARACTERISTICS

Item	Quantity 100	1,000	10,000
Equipment - Group Delay - Modulator $15,000	$150	$15	$1.5
Additional PCB for Corrector	$3.58	$3.35	$3.30
Alignment	$2.28	$1.35	$1.35
Total Per Set	$155.86	$19.70	$6.15

Note: If production more than 80 a day equipment is double.

APPENDIX I

1. Charles M. Close: The Analysis of Linear Circuits

2. Television Receiver Design Aspects for Employing Teletext LSI
   Tadahiko Suzuki, Okada Y., et al, IEEE Transaction on CE
   Vol. CE-25, July 1979

3. Experimental Studies of Transmission Bit-rate for Teletext signal
   Yasutaka Numaguchi, Harada S., et al
   IEEE Transaction on Broadcasting, BC-25 No. 4
   December 1979

4. Television Demodulator Standards
   T. M. Gluyas
   IEEE Transaction on CE
   Vol. - 23, No. 3, August 1977

5. Performance Comparison of TV Transmitter RF Demodulators and the Home Receivers
   William L. Behrend
   IEEE Transaction on Broadcasting
   Vol. - 17, No. 1, March 1971

6. A frequency-domain interpretation of echoes and their effect on teletext data reception
   C. Bailey Neal, Goal S.K.
   IEEE Transaction on CE
   Vol. CE-25, No. 3, July 1979

7. Frequency and amplitude dependant phase effects in television boradcast system
   C. Bailey Neal, Goal S.K.
   IEEE Transaction on CE, Vol CE-23, No. 3, August 1977

8. New Dolor Television Receiver with SAW IF Filter and one Chíp PIF IC
   H. Nabeyama, Shimano M. et al
   IEEE Transaction on CE
   Vol. 25, February 1979

9. C46 Chassis Manual

10. EIA Standard RS-462

APPENDIX D

P. Anthony

Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications

Communications Research Centre,
P.O. Box 11490, Station "H",
Ottawa, Ontario K2H 8S2

Your file Votre référence

Our file Notre référence

March 31, 1981

Mrs. Joan Elson,
ER Section, Division No. 5,
Dept. of Supply and Services,
Data Processing Procurement,
Place du Portage, Phase III,
3C2 via 4C1,
11 Laurier St.,
Hull, Quebec
K1A OS5

Dear Mrs. Elson:

Re: Contracts with Electrohome,
DSS File No. 3ER .36001-0-3071
Amended per 3ER .36001-0-3497
DSS File No. 3ER .36001-0-3199
Acknowledgement of Deliverables

References: Electrohome Memorandum
Pat Anthony to Kuruc et al,
5 March '81 (attached)

This will corroborate the contents of the referenced memorandum with respect to the two subject contracts and our concurrence with it. In addition, the following should be noted for the record:

Re: 0-3497

1. All Stage I and II hardware deliverables were received as expected. Continuation approval from Stage I to Stage II is herein re-confirmed. Final reports are expected to meet schedule.

2) Rather than waiving 699E testing in entirety, CRC has done a number of preliminary tests. These confirm reasonable compliance with DOC expectations for meeting 699E requirements. Conditional approval can, therefore, be given for the units as prototypes.

.../2

3) The development of the external sync feature in the Stage II hardware deliverables has proved to be a more complex and difficult problem than originally expected and allowed for. In effect, it is beyond the scope of the present contract and must be excluded at this time.

4) It is understood that modem certification under the DOC Terminal Attachment Program will be sought by Electrohome and/or the modem manufacturer in due course.

Re: 0-3199

1) The interim reports was received and the final report will be ready for review as scheduled.

Best Regards,

G. Dobbin,
Information Technology

cc: W. Sawchuk
J. Storey
R. Warburton
P. Anthony, Electrohome
J. Blackburn, Electrohome

March 5, 1981

M E M O R A N D U M

TO: T. Kuruc, J. James, J. Blackburn, G. Gallagher
c.c. D. Knight, T. Muffitt, (Electrohome)
D. O'Brien, G. Dobbin (C.R.C.)
J. Elson (D.S.S.)

SUBJECT: PHONE REVIEW OF PLUG AND INTEGRATION STUDY WITH D. O'BRIEN AND G. DOBBIN OF C.R.C.

Integration Study (D.S.S. File 3071)

It was noted that the Stage I part of this study is essentially complete and the following items will be carried into Stage II.

a) Modem auto-dial software/hardware implementation for dial from the key pad function.

b) Terminal software/hardware implementation using VC404 type functions.

c) Telidon command key code re-allocation using the 80 Hex off-set.

The conclusion to drop the printer function was discussed noting complexity and timing limitations and that an alternative exists using an 'RGB' recorder.

A waiver on the acceptance test plan was agreed in light of the complexity and lack of slide release from D.O.C. G. Dobbin will follow this item up with a letter to J. Elson.

In conclusion Mr. Dobbin was requested to give approval for continuance into Stage II and he agreed.

Stage II is expected to go as planned, except there is a major concern that Norpak will not be able to deliver the sync option required. G. Dobbin has agreed to review and respond to this issue.

The deliverables are expected to be complete in time for the March 31, 1981 deadline at this time. However Norpak have indicated late delivery (March 23, 1981) of the teletext modules, repair in April may be necessary.

Plug Study (D.S.S. File 3199)

It was noted that March 9, 1981 delivery will be too tight due to testing time required and unexpected technician difficulties. However completion by March 31, 1981 should be no problem.

In light of the above Mr. O'Brien requested a point form summary of the outcome be prepared for March 11, 1981 to be discussed with the writer on the way to the Vancouver C.V.C.C. Standards Meeting and that it be presented to that body by the writer.

Mr. O'Brien requested emphasis be given also to:

a) Why our recommended plug is or is not a better choice than the Sony ElAJ8 plug used in educator product.

b) Cross talk and ground loop problems.

c) Radiation caused by equipment interconnect.

Mr. O'Brien also requested the writer address the C.V.C.C. on the finding of 'GML' re: the RS232 jack sex, terminal parity, and baud rate setting.

Patrick R. Anthony
Manager
Videotex Marketing

APPENDIX E

6.0 APPENDICES

6.1 Appendix A - Norpak Report - Stage I

6.2 Appendix B - GML Market Study

6.3 Appendix C - Group Delay Study

6.4 Appendix D - Stage I Review

6.5 Appendix E - Norpak Report - Stage II

norpak

P348 REPORT.
ELECTROHOME
STAGE II
DOCM: D3809

NORPAK LIMITED
PAKENHAM, ONTARIO
CANADA
K0A 2X0

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Rev 1 26-MAR-81

TABLE OF CONTENTS

1.0 INTRODUCTION.....3
2.0 HARD COPY.....4
3.0 KEYCODES.....5
4.0 AUTO DIAL.....7
5.0 ASCII TERMINAL.....8
6.0 MODULE ORGANIZATION.....9
7.0 COSTING.....10
8.0 COMMENTS.....11
9.0 APPENDIX.....12

1.0 INTRODUCTION

This report details the implimentation of additional functions on a Norpak Telidon MKII terminal emulation. (refer to Stage I report).

Functions include re-allocation of key codes, auto dial and an ASCII terminal. Costing of these function is included.

There are also comments regarding the implimentation Electrohome's integrated terminal.

2.0 HARD COPY

Hard copy output for Videotex information was not implimented due to problems outlined in the Stage I report (document D3808).

3.0 KEYCODES

The keycodes on the MK3 have been altered to accept the previous keypad and keyboard codes as well as an supplimentary keypad code set.

Re-allocation of the keypad codes enables a standard alpha-numeric keyboard, with a simple modification, to also generate keypad functions. Implimentation of this requires that the most significant data bit, bit 7, be set to zero for ASCII operation and to a one for Teltdon.

Keypad codes are shown in figure 3-1.

Keycodes

KEYPAD

Symbol	Current Code	Character transmitted	New code + $80
TV	E0		T - D4
V/T	E8		V - D6
S	F0	S - 53	S - D3
R	F8	R - 52	R - D2
"	E2	" - 22	" - A2
□	EA		C - C3
▽	F2		P - D0
⌫	FA		ESC - 9B
1	E4	1 - 31	1 - B1
2	EC	2 - 32	2 - B2
3	F4	3 - 33	3 - B3
4	E5	4 - 34	4 - B4
5	ED	5 - 35	5 - B5
6	F5	6 - 36	6 - B6
7	E6	7 - 37	7 - B7
8	EE	8 - 38	8 - B8
9	F6	9 - 39	9 - B9
F	E7	F - 46	F - C6
0	EF	0 - 30	0 - B0
.	F7	. - 2E	. - AE
⏎	FF	<CR> -0D	<CR> - 8D
←	E3	< - 3C	< - BC
→	EB	> - 3E	> - BE
↑	F3	^_ 5E	^_ DE

Figure 3-1 Keypad key codes

4.0 AUTO DIAL

Using a general Datacom modem, model GDC-CDN-120/15, the Telidon NK3 can dial a user's telephone number connection.

This function is activated by means of the F73 function on the Telidon keypad.

The format is F73.X where X is a combination of dots (.) and digits representing a telephone number, area code, long distance code, etc.

i) each digit represents a digit dialed on a telephone
ii) each dot represent a pause of 1.5 seconds to allow for delays in acquiring lines in the telephone system.

Some examples are:

a) F73.744.7111 local call
i.e. - dial exchange 744, pause, dial 7111

b) F73.9..1.519.744.7111 long distance through PBX
i.e. - dial 9 for an outside line, pause 3 sec.
- dial long distance
- dial area code, pause
- dial exchange, pause
- dial number 7111

During the dialing process, there is an automatic delay of 0.5 seconds between digits. At the end of a dial sequence there is a delay of 1 second before the modem is put into "data" mode. There is an additional 1 second delay after going into data mode before the terminal responds to the line. This is to allow for the answer back tone. Dial pulsing is 67 milliseconds off, 33 milliseconds on.

To abort the connection, press ^V, wait 2 seconds and the line will disconnect.

It should be noted that this auto dial feature requires a special modification to the modem. In addition, use of this dialing procedure and any "permissive" telephone connection does not meet regulatory approval.

5.0 ASCII TERMINAL

The terminal type, that has been implimented in the MK3 alpha module, is a Volker-Craig VC404.

Functions within the terminal that have been implimented are:

a) 24 line, 80 character per line format
b) normal or reverse video
c) transparent mode display of control codes
d) control code compatibility including cursor addressing
e) line/local mode and local echo for half duplex
f) standard VCL character fonts
g) options are not included

For a full list of functions, refer to appendix A.

In order to sum the alpha output video with the MK3 video several changes must occur:

a) all bus components must operate at 1.8 MHz, impling 2.0MHz components (68B09, 68B21, etc).
b) the ram memory must be able to operate at 280 ns cycle time instead of 375 ns.
c) addition video circuitry to perform the actual summing operation.

6.0 MODULE ORGANIZATION

Auto dial, supplimentary key codes, and the ASCII terminal emulation take the form of three software modules. These modules are organized into two distinct eprom maps:

	AUTO DIAL	KEYCODES	ASCII
D3430	–	*	*
D3427	*	*	–

7.0 COSTING (Budgetary)

ITEM	QUANTITY	COST
Auto dial (increased modem cost)	1k	$15
ASCII terminal (alpha bd only)	1k	$80
	10k	$60
	100k	$40

8.0 COMMENTS

The following is a list of several points regarding Electrohome's integrated terminal which are worth considering:

a) there is a problem with heat dissipation in the enclosure in the area of the MK3. The temperature exceeds 40 degrees C in many places with ambient air temperature of 23 degrees C.

b) in teletext applications, there is no indication of correct channel tuning.

c) the tuner module needs additional work in order to properly demodulate the teletext signal. The clock run - in portion of the teletext signal is currently non-existent.

d) the MK3/907 video interface could be re-designed to minimize circuit complexity and physical connections.

e) the proposed Electrohome keyboard, a flat panel pressure sensitive type, should be reconsidered.

f) the "permissive" phone connection, with auto dial ability, requires regulatory approval.

g) the terminal should be CSA approved. Regarding DOC approval, the current DOC specification complies with FCC regulations regarding radio frequency interference limits. A substantial effort will likely be required to meet this standard.

APPENDIX A

ASCII TERNINAL - VC404

SECTION 1

INTRODUCTION

1.1 GENERAL

This high-performance, teletype-compatible display terminal is an input-output device which transmits and receives information from a central processor or computer time-share system. This interactive terminal is designed to meet requirements in the telecommunications, data processing, and computer industries. Applications include small systems, time-sharing, information display systems, credit/banking systems, and minicomputer/microcomputer systems.

Data communication is possible using a modem and acoustic coupler or a direct computer-to-terminal connection via the EIA, RS232C (CCITT V.24) compatible interface connector at data rates up to 19200 baud. A 20 milliamp current loop cable interface is an optional accessory.

The basic terminal includes an upper/lower case typewriter style keyboard with control keys, communications electronics, and a 12" non-glare video display screen for a 24 line, 80 character per line format. Data entry occurs in either a bottom line mode with single line scroll up or a page mode. Options to the terminal include serial and parallel peripheral interfaces, coloured display screens, numeric pad and function keys, APL character set (non-overstrike), and many foreign keyboards and character sets.

1.2 DISPLAY TERMINAL FEATURES AND OPTIONS

The basic video display terminal is a stand-alone, ASCII, serial asynchronous computer peripheral for use on any system with an RS232C (CCITT V. 24) interface.

Standard features on the terminal include:

Detachable upper/lower case typewriter style keyboard.

Switch selectable upper/lower case.

Display of 1920 characters in a 24 line, 80 character per line format.

12" anti-glare display screen.

Normal or reverse video.

Four-Way cursor flashing or steady-block or underline selectable.

Front panel controls: Power Off/On, Local/Remote, Half/Full Duplex, Roll/Page, ASCII/APL switches.

Transparent/Tape Mode switch allows display of 95 or 128 characters. All control codes displayed when mode is On.

Bottom line entry in Roll Mode.

Page overwrite in Page Mode.

Automatic word wrap around on video display after the 80th character position.

Automatic alarm (Control G, BEL code).

Auto-Repeat, characters repeat at 15 char/sec.

Absolute x-y cursor addressing.

Clear to 'End of Line' and 'End ofScreen' functons.

8-position baud rate select switch on rear panel. Select from 110, 300, 600, 1200, 2400, 4800, 9600, 19200 baud.

Parity select switch on rear panel.

EIA RS232C (CCITT V.24) communications interface. (20mA. current loop accessory available.)

Serial or parallel peripheral interfaces (optional).

Optional numeric pad and function keys.

APL and many foreign keyboards and displays available.

EXPORT version (230V/50Hz) easily user-configurable.

1.3 TERMINAL OPTIONS

OPTION APL — Provides front panel switch selectable ASCII and APL character set (no overstrikes). APL is typewriter paired.

OPTION SPI — Serial Peripheral Interface. This switched EIA interface is bidirectional for use with a printer, cassette, floppy disc, or other serial peripheral devices. This port is enabled locally by depressing the PRINT key on the keyboard or remotely by the Control Q (Turn On) and Control S (Turn Off) ASCII codes. This option is implemented using a 25 pin DB Type connector located on the rear of the terminal.

OPTION PIP — Auxiliary Parallel Input. ASCII input port used with accessory items such as the Bar Code Reader Interface (BRI). There are 7 input bit lines plus a strobe bit line, power and control lines. This 25-Pin connector is located on the rear panel.

OPTION CDS — Coloured anti-glare display screen (specify Amber, Green).

OPTION KB1 — Adds a numeric pad and function keys to the keyboard.

SECTION 2

OPERATION

2.1 OPERATING CONTROLS

The main controls for establishing the terminal's mode of operation, LOCAL, FULL, PAGE, and APL are located on the keyboard. These and other controls are as follows:

CONTROL	LOCATION	FUNCTION
POWER	Front	Controls power to terminal (Part of Brightness control).
LOCAL	Keyboard	When depressed, the terminal is in a LOCAL (Off-Line) mode. When up, the terminal is in REMOTE (On-Line) mode.
FULL	Keyboard	Switch selects HALF (Up) or FULL (Depressed) DUPLEX mode.
PAGE	Keyboard	Switch selects screen presentation mode, Page overwrite (depressed) or bottom line (Up) entry with scroll-up.
APL	Keyboard	When depressed, selects screen display. It is used with the APL character set.
BAUD RATE	Rear	Thumbwheel switch selects one baud rate from 110, 300, 600, 1200, 2400, 4800, 9600, 19200 baud.

Switch Pos.	Baud Rate
0	110
1	300
2	600
3	1200
4	2400
5	4800
6	9600
7	19200

BRIGHTNESS	Front	Control knob adjusts brightness of screen display and POWER on/off.
CAPS ONLY	Keyboard	When depressed, the terminal is in CAPS LOCK mode. Shifts lower-case alphabetic characters to upper-case.
PARITY	Rear	Toggle switch selects odd, even or no parity (normally mark; may be internally changed to space parity).
TRANSPARENT	Rear	Switch selects 95 or 128 character set display. All control codes displayed when switch is ON.

2.2 KEYBOARD FUNCTIONS

All keyboard keys generate ASCII codes with the exception of the BREAK Key. APPENDIX H identifies which codes are used for the individual characters and control functions. For example, Control M executes a carriage return. Characters repeat automatically if the key held depressed for more than .75 seconds. APPENDIX F shows keyboard layouts.

BREAK

The data output lines are put into a space condition for as long as the key is depressed.

CONTROL CHARACTERS

Control characters are transmitted by depressing the CTRL key and the character key simultaneously or by depressing the control key first and holding it down while depressing the character key. These codes are transmitted by the terminal.

CURSOR LEFT (Control H)

Moves the non-destructive cursor one character position to the left. If the cursor is positioned at the beginning of a line, issuing this command will have no effect.

CURSOR RIGHT (Control U)

Moves the non-destructive cursor one position to the right. When the cursor reaches the last character position in a line, it wraps around to the beginning of the next line. In PAGE mode the cursor moves from the last position of the last line to the first position of the first line when a cursor right command is issued.

CURSOR DOWN or LINE FEED, LF (Control J)

This command moves the non-destructive cursor down one line. If the cursor is on the bottom line the text scrolls up. In Page Mode the cursor moves to the top line.

CURSOR UP (Control Z)

Moves the non-destructive cursor up one position. If the cursor is on the top line, cursor remains fixed.

CURSOR HOME (Control Y)

Moves the non-destructive cursor to the upper left hand corner, without clearing screen.

CLEAR (Control X)

When this key is depressed, the entire screen is cleared of all information and the cursor moves to the upper left hand corner (allow 40 ms.).

CLEAR TO END OF LINE (Control V)

When this key is depressed, the line upon which the cursor is currently positioned is cleared from the cursor to the end of that line. the cursor position remains unchanged.

CLEAR TO END OF SCREEN (Control W)

When this key is depressed, all information is cleared from the cursor position to the end of the screen. The cursor position remains unchanged (allow 40 ms.).

RETURN (Control M)

When depressed, the cursor is moved to the beginning of the line on which it is positioned.

CONTROL P (X-Y Cursor Addressing)

Direct cursor positioning is provided following the receipt of the appropriate control code (Control P). The next character received will cause the cursor to move to a line position (Y direction) as defined in the table in APPENDIX A. In a similar manner, the next character will cause the cursor to move to a character position (X direction) as defined in the table. Note that motion can be inhibited in one direction or the other.

ESC (Escape)

When depressed, the ASCII code for the ESCAPE function is transmitted, but not displayed. When received, the code has no effect on terminal operation.

2.3 TURN-ON PROCEDURE

Become familiar with all controls, switches, and indicators on the terminal before attempting to sign on to any computer system. The following procedure should be followed when signing on:

1. Turn the BRIGHTNESS control knob clockwise to turn the power ON.
2. Place LOCAL switch on keyboard to LOCAL.
3. Depress a few character keys to fill the screen with a few lines of characters.
4. Adjust BRIGHTNESS control knob to display bright, crisp characters.
5. Execute a CONTROL X (or depress CLEAR key) to clear screen and home the cursor.
6. Set the PARITY ODD/EVEN/NO toggle switch on rear panel to required position.
7. Select the BAUD RATE to be used with the rear panel thumbwheel switch.
8. Set the LOCAL keyswitch to the Up position and the FULL Duplex (Up for HALF, down for FULL) keyswitch to the required position and begin sign-on procedure.

2.4 MODES OF OPERATION

LOCAL

In the LOCAL MODE, no signal transmission is made to the computer through the input/output connectors on the rear panel. LOCAL MODE may be used for testing keyboard functions or working in an off-line mode.

HALF DUPLEX, REMOTE

In this mode data is simultaneously displayed on the screen and transmitted to the computer each time a key is depressed.

FULL DUPLEX, REMOTE

In this mode, two way communications exists between terminal and computer. When a key is depressed, the data is transmitted to the computer and then displayed on the terminal screen only after the computer has echoed back the character for display verification. The terminal's operator is assured character-by-character verification of the transmitted data.

TRANSPARENT/TAPE

When the TRANSPARENT MODE switch located on the rear chasis is in the ON position all control codes received by the terminal from the computer or keyboard are displayed on the screen. No cursor control codes are active and all data is continuously displayed as one string, wrapping around at the 80th character position. Control characters are displayed preceded by a small c to identify them as such (i.e. Control G is C_G, Control X is C_X, etc.). This mode is extremely useful for debugging computer programs or monitoring completely the communications line data.

2.5 COMMUNICATIONS INTERFACE

This consists of a 25-PIN, rear panel input/output connector marked "SERIAL DATA (RS232-C DTE)" and conforms to the EIA RS232C (CCITT V.24) standards. The pin connections are described in APPENDIX B. A 20 mA current loop can beimplemented using a special cable assembly, Part Number CI04-2M.

RECOMMENDED EIA CABLING LENGTHS

BAUD RATE	MAXIMUM CABLE LENGTH (M)
110	2400
300	1200
600	600
1200	300
2400	150
4800	75
9600	40

For speeds greater than 2400 Baud and lengths greater than 15 meters, all data and control signals should be carried as twisted pairs using pins 1 to 7 as returns.

2.6 MODEMS AND ACOUSTICAL COUPLERS

If external modems and couplers are used, connection to the terminal is made through the 25 PIN RS232C (CCITT V.24) connector. When the computer operates in HALF DUPLEX mode the modem and the terminal must be operating in different modes, otherwise, characters will be repeated on the terminal display screen due to the signal echo back from the modem and the locally generated character.

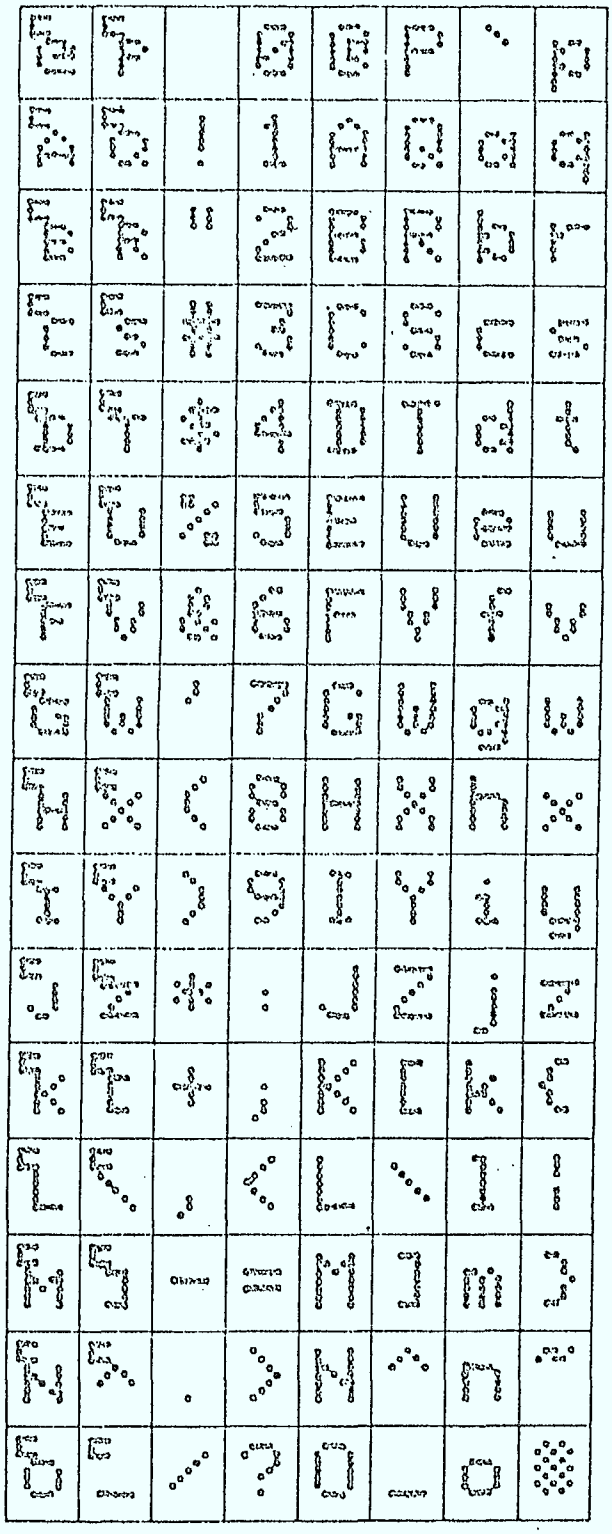
APPENDIX A

DIRECT X-Y CURSOR ADDRESS COMMAND (CTRL P.Y.X)

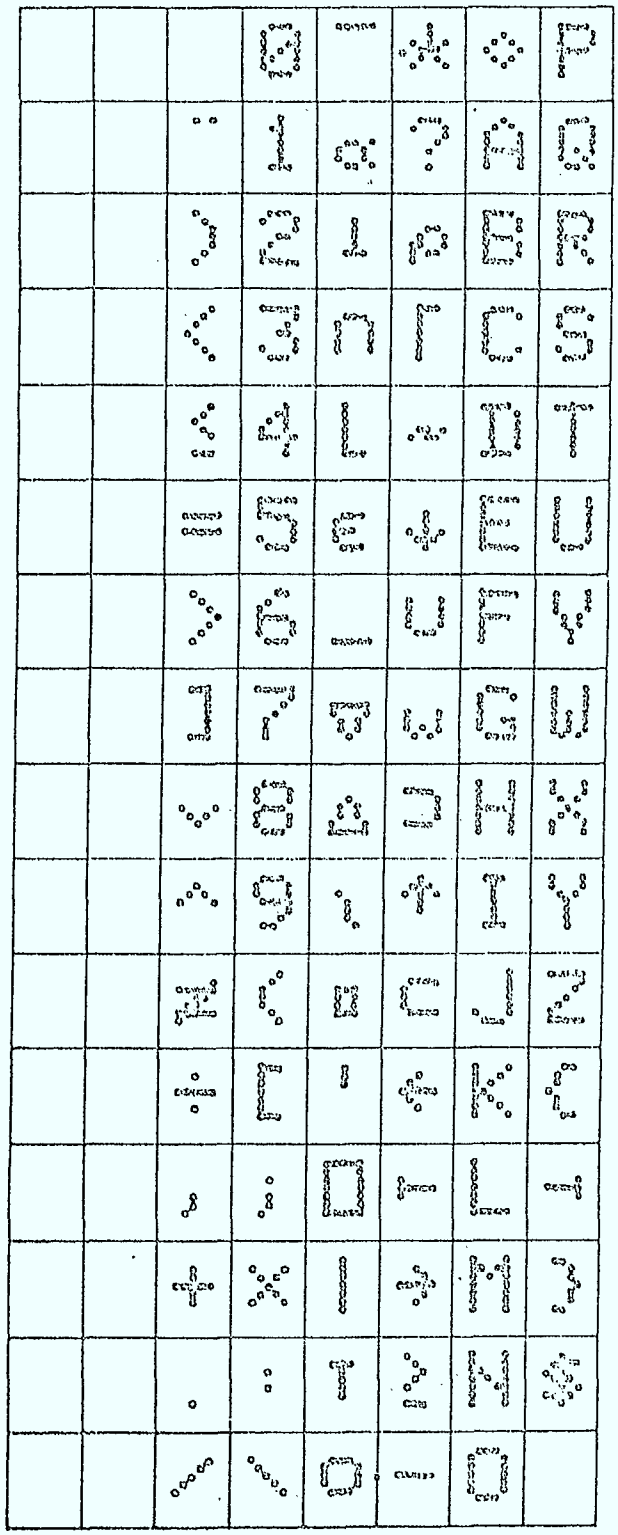
The cursor address command allows the cursor to move to the screen position specified by the next two characters. The 7 bit ASCII code for the first character entered gives the Y-Position and the 7-bit ASCII code for the second character entered gives the X-Position. The character co-ordinates are in binary format (offset by 20 Hex).

X-POSITION	CHARACTER	X-POSITION	CHARACTER	Y-POSITION	CHARACTER
0	(Space)	41	I	0	(Space)
1	!	42	J	1	!
2	"	43	K	2	"
3	#	44	L	3	#
4	$	45	M	4	$
5	%	46	N	5	%
6	&	47	O	6	&
7	'	48	P	7	'
8	(	49	Q	8	(
9	)	50	R	9	)
10	*	51	S	10	*
11	+	52	T	11	+
12	,	53	U	12	,
13	-	54	V	13	-
14	.	55	W	14	.
15	/	56	X	15	/
16	0	57	Y	16	0
17	1	58	Z	17	1
18	2	59	[	18	2
19	3	60	\	19	3
20	4	61	]	20	4
21	5	62	^ (circumflex)	21	5
22	6	63	_ (underscore)	22	6
23	7	64	` (grave accent)	23	7
24	8	65	a	No motion	8
25	9	66	b		
26	:	67	c		
27	;	68	d		
28	<	69	e		
29	=	70	f		
30	>	71	g		
31	?	72	h		
32	@	73	i		
33	A	74	j		
34	B	75	k		
35	C	76	l		
36	D	77	m		
37	E	78	n		
38	F	79	o		
39	G	No motion	p		
40	H				

VCL CHARACTER FONTS



UPPER/LOWER CASE ASCII
(STANDARD)



TYPEWRITER PAIRED APL
(OPTION APL)

APPENDIX H

VC404 ASCII ENCODING CHART

(Including Hex-code Equivalents)

					← CONTROL CHARACTERS* →		← DISPLAYED CHARACTERS →					
				B7	0	0	0	0	1	1	1	1
				B6	0	0	1	1	0	0	1	1
				B5	0	1	0	1	0	1	0	1
				COL →	0	1	2	3	4	5	6	7
B4	B3	B2	B1	ROW ↓								
0	0	0	0	0	NUL @ 00	DLE (CURSOR ADDRESS) P 10	20	0 30	@ 40	P 50	` 60	p 70
0	0	0	1	1	SOH A 01	DC1 (SPI ON) Q 11	! 21	1 31	A 41	Q 51	a 61	q 71
0	0	1	0	2	STX B 02	DC2 R 12	" 22	2 32	B 42	R 52	b 62	r 72
0	0	1	1	3	ETX C 03	DC3 (SPI OFF) S 13	# 23	3 33	C 43	S 53	c 63	s 73
0	1	0	0	4	EOT D 04	DC4 T 14	$ 24	4 34	D 44	T 54	d 64	t 74
0	1	0	1	5	ENQ E 05	NAK (CURSOR RIGHT) U 15	% 25	5 35	E 45	U 55	e 65	u 75
0	1	1	0	6	ACK F 06	SYN (CLEAR TO EOL) V 16	& 26	6 36	F 46	V 56	f 66	v 76
0	1	1	1	7	BEL (BELL) G 07	ETB CLEAR TO EOS W 17	' 27	7 37	G 47	W 57	g 67	w 77
1	0	0	0	8	BS (CURSOR LEFT) H 08	CAN (CLEAR) X 18	(28	8 38	H 48	X 58	h 68	x 78
1	0	0	1	9	HT I 09	EM (HOME) Y 19	) 29	9 39	I 49	Y 59	i 69	y 79
1	0	1	0	10	LF (CURSOR DOWN) J 0A	SUB (CURSOR UP) Z 1A	* 2A	: 3A	J 4A	Z 5A	j 6A	z 7A
1	0	1	1	11	VT K 0B	ESC [1B	+ 2B	; 3B	K 4B	[5B	k 6B	{ 7B
1	1	0	0	12	FF L 0C	FS \ 1C	, 2C	< 3C	L 4C	\ 5C	l 6C	| 7C
1	1	0	1	13	CR (CARRIAGE RETURN) M 0D	GS] 1D	- 2D	= 3D	M 4D	] 5D	m 6D	} 7D
1	1	1	0	14	SO N 0E	RS ^ 1E	. 2E	> 3E	N 4E	^ 5E	n 6E	~ 7E
1	1	1	1	15	SI O 0F	US _ 1F	/ 2F	? 3F	O 4F	_ 5F	o 6F	DEL 7F

∞ Hex-Code

Displayed characters

Terminal Functions

Codes generated and transmitted by terminal but no action taken on display.

*All control Characters displayed in Transparent/Tape Mode i.e. HT as ^I, STX as ^B.

A STUDY OF INTEGRATED TELIDON TERMINAL DESIGN CONSTRAINTS
v.1 Report.

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