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## 1. INTRODUCTION

During March-May 1979, a Honeywell Model H-153 groupbandwidth data modem, operating at 144 kbit/s was tested over various groupband loops terminating in the Telecom Australia Research Laboratories in Clayton, Victoria.

Because of the variability of some of the bearers and the limited availability of this modem from the manufacturer, the main emphasis in these tests was on the comparative performance with a V-36 data modem operating at 72 kbit/s. The parameters recorded in these tests were the bit error rate, block error rate and carrier losses (or failures).

In addition the performance of this modem was measured using the microprocessor-controlled data test set developed by the Research Laboratories. This test set monitors the performance in terms of Error-Free Seconds.

This report summarizes the results of these measurements.

## 2. HONEYWELL MODEL H-153 DATA MODEM

This modem uses a 7-level class 4 partial-response (PR) single sideband amplitude modulated (SSBAM) line signal and is compatible with the CCITT requirements for operation on a groupband (V.36 Recommendation). It can operate at a variety of speeds from 112 to 168 kbit/s, but for these tests a speed of 144 kbit/s has been adopted. The modem also provides a 2 or 3 port multiplexing facility (eg. 2 x 72 kbit/s or 3 x 48 kbit/s ⇒ 144 kbit/s) but this option was not used in these tests.

The transmit level of the line signal was set to -6.0 dBm0 and the 11-stage scrambler was strapped in the non-self-synchronizing mode. The modem has an adaptive 66-tap linear transversal equalizer which minimizes the effects of linear distortion, especially the group delay distortion from the through-group filters and the through-supergroup filters (affecting groups 1 and 5). This equalizer also minimizes the effect of residual carrier and clock phase errors at the receiver.

The V.36 data modem used in the comparative tests operates at 72 kbit/s using a 3-level class 4 PR SSBAM line signal but without adaptive equalization. The carrier phase error is adjusted manually to optimize the eyepattern.

If the received signals are perfectly equalized, the 3-level 72 kbit/s modem would be 7 dB less sensitive to noise than the 144 kbit/s modem and be able to tolerate a 21° phase hit in contrast to 7°. However in practice the advantage of the adaptive equalization in the higher speed modem could be expected to approximately offset the disadvantage of its increased number of levels.

## 3. TEST PROGRAMME

The comparative tests were conducted on groupband loops to Sydney (which includes an extra loop to Wagga Wagga), Canberra and Launceston from the Clayton Laboratories. All loops are on radio bearers except the Sydney loop which is on coaxial cable.

The procedure adopted during the comparative tests was to interleave the operation of each modem (i.e. the Honeywell and the V.36 Modem) about every 0.5 to 1 hour during the working day to ensure that the bearer variability is not a factor in the comparison. The data transmission performance was measured with a HP 1645A data test set with the block length set to 100,000 bits.

The HP test set was configured to count the number of carrier losses (or carrier failures) as detected by the data modems, rather than data dropouts (i.e. 16 consecutive clock periods without transitions). The bit error count is inhibited by carrier losses, clock slips (as detected by the test set) and data dropouts, but the test set has been modified to enable the block error count to continue during these three events.

The measurements, using the Research Laboratories data test set, were carried out on the loops to Adelaide and Perth. They were made using only the Honeywell 144 kbit/s modem.

## 4. RESULTS OF MEASUREMENTS

The results of the (interleaved) comparative measurements are shown in Appendix I. The results indicate that the two modems have a comparable performance except perhaps on the Melbourne-Sydney (Wagga Wagga) loop. It may be noted that this loop has 5 through-group filters instead of 3 in the other loops used in the comparative tests of the two modems.

The results of the measurements using the microprocessor-controlled data test set are shown in Appendix II. The low availability for the first week of the Adelaide loop tests and for the Perth loop tests is caused by loss of synchronism in the receive data. This is believed to be caused by loss of synchronism of the non-self-synchronizing descrambler in the data modem receiver and the resulting very high error rate until this situation is manually rectified. The data test set if it detects a very high error rate will go into a resynchronizing mode but this is fruitless if the data descrambler is out of synchronism. This lack of synchronism was caused in the first week of the Adelaide loop tests by mains power interference but this was subsequently rectified with a filter for the remaining tests. The loss of synchronism in the Perth loop tests is believed to be caused by transmission impairments.

## 5. CONCLUSION

The Honeywell H-153 data modem has been tested on various groupband loops when operating at 144 kbit/s. These tests have been firstly on a comparative basis with a CCITT Rec. V-36 (72 kbit/s) data modem and also using the microprocessor-controlled data test set developed by the Research Laboratories.

The main conclusion to be drawn from these tests is that the adaptive equalization used in the H-153 data modem enables it to have a comparable performance with the simpler V-36 data modem, when operating at the above rate.

## 6. ACKNOWLEDGEMENTS

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## APPENDIX I

### SUMMARY OF THE COMPARATIVE ERROR PERFORMANCE OF THE HONEYWELL 144 KBIT/S MODEM AND THE V-36 72 KBIT/S MODEM

LEGEND:

BER = Bit Error Rate
BKER = Block Error Rate (Block Length = $10^5$ bits)
* = Overflown Bit Error Counter
† = Test periods during which modem lost synchronization are excluded.

| PARAMETER | MELBOURNE-CANBERRA LOOP (1000 km) 23/3/79-3/4/79 | | MELBOURNE-LAUNCESTON LOOP (1200 km) 23/3/79-3/4/79 | |
|---|---|---|---|---|
| | HONEYWELL (144kbit/s) | V-36 (72kbit/s) | HONEYWELL (144kbit/s) | V-36 (72kbit/s) |
| Duration | 33 3/4 hrs | 31 1/4 hrs | 29 1/4 hrs | 33 3/4 hrs |
| Bit errors | 110470 | * | * | * |
| Block errors | 74 | 17 | 5565 | 3003 |
| Carrier losses | 2 | 5 | 176 | 43 |
| BER | $6 \times 10^{-6}$ | * | * | * |
| BKER | $4 \times 10^{-4}$ | $2 \times 10^{-4}$ | $4 \times 10^{-2}$ | $3 \times 10^{-2}$ |

| PARAMETER | MELBOURNE-CANBERRA LOOP (1000 km) 20/4/79-3/5/79 | | MELBOURNE-SYDNEY MELBOURNE-WAGGA WAGGA LOOP (2600 km) 20/4/79-3/5/79 | |
|---|---|---|---|---|
| | HONEYWELL (144kbit/s) | V-36 (72kbit/s) | HONEYWELL (144kbit/s) | V-36 (72kbit/s) |
| Duration | 37 1/4 hrs† | 37 3/4 hrs | 31 3/4 hrs† | 41 1/4 hrs |
| Bit errors | 3741 | 11109 | * | * |
| Block errors | 46 | 24 | 399 | 98 |
| Carrier losses | 1 | 12 | 13 | 35 |
| BER | $2 \times 10^{-7}$ | $1 \times 10^{-6}$ | * | * |
| BKER | $2 \times 10^{-4}$ | $2 \times 10^{-4}$ | $2 \times 10^{-3}$ | $6 \times 10^{-4}$ |

## APPENDIX II

### RESULTS OF MEASUREMENTS OF THE HONEYWELL 144 KBIT/S DATA MODEM USING THE RESEARCH LABORATORIES TEST SET

| Loop | Weekly Period | % Valid Time | % Availability* | % Error-Free Seconds in Available Time |
|---|---|---|---|---|
| Melb-Adel. (1500km looped) | 5/4/79-11/4/79 | 69.79 | 99.00 | 98.17 |
| | 12/4/79-18/4/79 | 100.00 | 99.94 | 99.41 |
| Melb-Perth (6800km looped) | 19/4/79-25/4/79 | 49.40 | 99.26 | 93.70 |
| | 26/4/79-2/5/79 | 77.38 | 94.97 | 92.96 |

* The data circuit is regarded as unavailable when 10 or more consecutive error-seconds are encountered.