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LOOP PERFORMANCE OF TWO 72 KBIT/S GROUPBAND DATA CIRCUITS

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LOOP PERFORMANCE OF TWO 72 KBIT/S GROUPBAND DATA CIRCUITS: MELBOURNE - ADELAIDE AND MELBOURNE - PERTH

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LOOP PERFORMANCE OF TWO 72 KBIT/S GROUPBAND DATA CIRCUITS: MELBOURNE - ADELAIDE AND MELBOURNE - PERTH

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ABSTRACT

As part of an investigation of data links which may be used in the proposed Digital Data Network (DDN), tests were conducted between January 1979 and April 1979 on two microwave radio groupband data loops, namely, Melbourne-Adelaide (4 weeks) and Melbourne-Perth (8 weeks). Data modems compatible with CCITT - V.36 Recommendation were used at a bit rate of 72 kbit/s. The availability and error performances of the two circuits were monitored using a microprocessor-controlled data test set developed by Transmission Systems Branch.

Over the test periods concerned, the DDN proposed performance objectives were met on the Melbourne-Adelaide circuit but not on the Melbourne-Perth circuit. The two loops had distinct error characteristics with widely-separated error-bursts for the Adelaide circuit and frequent short error-bursts for the Perth circuit. An important finding from these tests is that error-second outages (i.e. events of 10 or more consecutive error-seconds) can significantly degrade the availability of data circuits. Their availability performance cannot therefore be readily estimated from broad-band bearer records unless some knowledge is obtained on the characteristics of error-second outages.

1. INTRODUCTION

As part of an investigation into the performance of data links which may be used in the proposed Telecom Digital Data Network (DDN), tests were previously conducted on selected intercapital groupband data circuits using CCITT-V.35 48 kbit/s data modems. Some error performance results were described in Ref. 1, but no availability performances were estimated. As the tentative DDN performance objectives (Appendix A) have now been formulated by the DDN Working Party 1 - Data Transmission Performance Plan, it is highly desirable to conduct the data tests in accordance with these proposed requirements. A microprocessor-based data test set developed by Transmission Systems Branch allows such performance monitoring (Ref. 2).

Two groupband data loops, namely, Melbourne-Adelaide and Melbourne-Perth were tested between 8 March and 4 April 1979 and between 8 January and 4 March 1979, respectively. The data modem used in this series of tests is a CCITT-V.36 compatible modem operating at 72 kbit/s.

This report describes the availability and error performances of these two tests loops for the abovementioned periods. An insight into the error characteristics of each circuit is also given. In addition, the data performance parameters are compared with the broadband bearer performance parameters monitored by the South Australian Administration and good agreement is obtained. Major events affecting the performance results are indicated where possible.

2. DATA TEST ARRANGEMENT

For convenience, performance monitoring was conducted on a loop-back basis on the following two groupband circuits:

- Melbourne-Adelaide (via Bordertown)
- Melbourne-Perth (extension of the above circuit).

Both data test loops are on microwave radio bearers and their positions within the respective supergroup and 15 - supergroup assembly (15-SGA) are summarized in Table 1. Also included in this table are the corresponding positions of the test circuits used by Trunk Service Section, Regional Operations Branch (SA) in monitoring the performance of broadband bearers on these routes. Although this automatic monitoring programme is (presently) designed for telephony purposes, it provides useful information such as interruption and noise activities which also affect data transmission. The parameters monitored by the South Australian Administration are summarized in Appendix B. For detailed information, the reader is directed to Ref. 3 and related documents.

A microprocessor-controlled test set developed by Transmission Systems Branch (Ref. 2) was used to monitor the data transmission parameters which are directly related to the DDN proposed availability and error performance objectives (Appendix A). These parameters are measured in such a way as to provide some insight on the error behaviour of the circuits to be characterized. Details of the data test set facilities and associated computer analysis of the recorded data are described in Ref. 2.

3. MELBOURNE-ADELAIDE DATA TEST RESULTS

3.1 Availability and Error Performances

The overall data performance of the Melbourne-Adelaide test loop between 8 March 1979 and 4 April 1979 is summarized on a weekly basis in Table 2. The definitions of the various column headings can be found in Ref. 2. The percentage of error-free seconds (% EFS) refers to the error performance over a weekly period. This information allows the long-term (12 months) performance to be estimated if sufficient test data is available. On the other hand, the last three columns refer to the short-term error performance over 15-minute, 1-hour and 1-day intervals within the same weekly period. It is noted here that in the calculation of the percentage of time intervals meeting the objective, any intervals containing error-second outages (i.e. events of 10 or more consecutive error-seconds) are weighted according to the availability percentage within these intervals.

For the test period conducted, Table 2 indicates that the availability objective of 99.98% (for long-haul segment) was nearly met and that the long-term error performance objective of 99.55% EFS (for long-haul segment) was met. Regarding the short-term error performance, a high percentage (greater than 97% on the average) of 15-minute intervals achieved the objective of 99.1% EFS (for long-haul segment). Similar results were obtained for 1-hour and 1-day intervals.

3.2 Error Characteristics

These are represented on a weekly basis by the percentage histograms of bit error counts per error-second (BEC/ES) and of error-free-second runs (EFSR) as illustrated by Figs. 1 (a)-(d) and 2 (a)-(d), respectively. The first series of histograms give us an insight into the distribution of the number of bit errors per error-second, while the others provide us with some information as to how error-second events are distributed. From these plots, the weekly median BEC/ES and EFSR can be readily estimated and the corresponding overall median values obtained as shown in Table 3. For the test period concerned, the weekly median BEC/ES varied between 12 and 48 bit errors yielding an overall figure of 24 bit errors and the weekly median EFSR varied between 384 and 768 yielding an overall figure of 672 seconds. This implies that the majority of bit errors occurred in bursts and that these error bursts were widely separated. Note also that very few error-free time gaps exceeded 2048 seconds or approximately 34 minutes (Refer to Figs. 2(a)-(d)).

3.3 Comparison of Data Performance Results and SA Analogue Performance Results

As mentioned in Section 2, broadband performance parameters for the bearer carrying the groupband data test circuit are available from the South Australian Administration. For clarity, these are referred to as analogue performance parameters in contrast to data performance parameters associated with the data tests.

A comparison of these two classes of results indicates a strong correlation between the data performance of the groupband circuit under test and the analogue performance of the associated bearer.

a. Availability Performance

As indicated in Appendix A, a data circuit is said to be unavailable whenever an error-second outage (ESO), i.e. an event of 10 or more consecutive error-seconds is encountered. These (data) outages are caused by either one or a combination of the following impairments:

- Long interruptions (or long breaks) in the data signal (of duration equal to or greater than 10 seconds individually)
- Frequent short interruptions (of duration less than 10 seconds individually)
- Sustained noisy bearer conditions.

An interruption in the received signal can be detected by the data modem as a carrier failure (or carrier loss). This parameter is therefore inherently modem-dependent. For the particular CCITT-V.36 data modem used in this series of tests, a carrier failure is detected whenever the level of the 100 kHz carrier pilot drops 11 dB or more below nominal for more than 2 ms. The associated detection circuitry has a hystereris of at least 2 dB and a dead time of 17 ms. The minimum duration of a detected carrier failure is therefore 17 ms. In comparison, an interruption in broadband bearers (as measured by SA) corresponds to a level drop of 6 dB or more and as short as 1 ms. The associated detection circuitry

has a hysteresis of 2 dB and a dead time of 2 ms (see also Appendix B). Although the above parameters (carrier failures and analogue interruptions) differ in characteristics, they are in good agreement as indicated by Tables 4(a)-(c). To a certain extent, carrier failures may therefore be regarded as equivalent to SA analogue interruptions.

However, as the availability of a DDN data circuit depends on the occurrence of error-second outages (ESO), its performance cannot be readily estimated from availability information obtained for broadband bearers. For the test period considered, the total duration of ESO was about 21 times the total duration of carrier failures or of analogue interruptions (Table 4(c)). But none of the latter events had an individual duration equal to or greater than 10 seconds. This result implies that the unavailability of the data test circuit was wholly caused by a combination of frequent short interruptions and sustained noisy bearer conditions. It is interesting to note that the ratio of total duration of ESO to total duration of carrier failures would be reduced if long interruptions were encountered. However, these events are readily detected and can be significantly reduced by appropriate patching. On the other hand, it may be impractical to initiate patching when extensive error-second outages are present in the received data signal.

b. Error Performance

The comparison of data error performance and SA broadband bearer performance results is much more complex than that associated with data availability performance. No attempt is therefore made to analyze the above item in detail. However the error performance was significantly degraded for test periods containing interruption and noise activities as monitored by the SA Administration. As the noise impairments are sensed over 1-minute intevals (in accordance with telephony requirements, see Appendix B), they have reduced significance as far as data transmission is concerned. Out of the two noise parameters, namely, 3 pWop/km and 50,000 pWop, the distance-dependent term is the more relevant performance indicator.

4. MELBOURNE-PERTH DATA TEST RESULTS

4.1 Availability and Error Performances

The overall data performance of the Melbourne-Perth test loop between 8 January 1979 and 4 March 1979 is summarized on a weekly basis in Table 5. The low percentage of valid time in some weeks was associated with local loopback tests.

For the overall test period, none of the DDN proposed performance objectives were met on this data circuit. Regarding the short-term error performance, a very low percentage of 15-minute intervals achieved the proposed objective of 99.1% EFS. Consequently, to see how this short-term performance varied with different threshold levels of % EFS, a sensitivity analysis was carried out. Figure 3 illustrates the results of this calculation on a weekly basis for % EFS varying between 90% and 99%. An "average plot" is drawn for the Melbourne-Perth test circuit and for comparison purposes, the corresponding result for the Melbourne-Adelaide test circuit (over a different time period) is also included.

4.2 Error Characteristics

These are represented on a weekly basis by the percentage histograms of bit error counts per error-second (BEC/ES) and of error-free-second runs (EFSR) as illustrated in Figs 4(a)-(h) and 5(a)-(h), respectively. The BEC/ES plots in Figs 4 indicate that a large proportion (around 50% or more) of error-seconds contained three-bit errors. These triple errors in fact correspond to single decision errors in the received line signal; the single errors have been multiplied by the self-synchronizing descrambler in the data modem. The dominant presence of triple bit errors is a distinct contrast to the bit error counts per error-second characteristic obtained for the Melbourne-Adelaide test circuit (over a different period).

The difference is also observed for the EFSR plots associated with the two data loops. For the Melbourne-Perth circuit (Fig. 5), the error-free time gaps between successive error-seconds were short (1 or 2), and these dominated the overall results (between 30% and 50%). On the other hand, a near "mirror image" characteristic was obtained for the Melbourne-Adelaide test circuit (over a different period) (Figs 2).

From the BEC/ES and EFSR histograms of the Melbourne-Perth test, the weekly median BEC/ES and EFSR can be readily estimated and the corresponding overall median values obtained as shown in Table 6. For the test period concerned, the weekly median BEC/ES varied between 3 and 6 bit errors yielding an overall figure of 4 bit errors and the weekly median EFSR varied between 1 and 6 yielding an overall figure of 4 seconds. This implies that the majority of bit errors occurred in short bursts (and in triples as discussed earlier) and that these error bursts occurred frequently. This result is in distinct contrast with the error characteristics observed on the Melbourne-Adelaide loop (over a different test period).

4.3 Comparison of Data Performance Results and SA Analogue Performance Results

This comparison indicates a strong correlation between the data performance of the groupband circuit under test and the analogue performance of the associated bearer.

a. Availability Performance

Tables 7(a)-(e) show the daily results associated with the data unavailability of the test circuit and the SA results on interruption activities of the broadband bearer concerned. Good agreement is obtained between these interruptions and the carrier failures as detected by the data modem. Any differences are due to one or both of the following causes:

- Faults occurring in the Russell-Lonsdale-Clayton section.

- Data test periods contain invalid time intervals caused by local loopback tests.

Major impairment events (e.g. interruptions and noise activities) were, where possible, located and identified by SA Trunk Service Section. These are also noted in Tables 7(a)-(d). During this data test, on 30 January 1979 a planned broadband bearer withdrawal of 61 minutes was detected by the data test set in the form of long carrier failures (and therefore error-second outages). This was subsequently confirmed by the SA broadband performance record indicating that the planned withdrawal was initiated on the Adelaide-Perth section of the test bearer. The time associated with this event is therefore excluded as invalid from the performance analysis.

As in the case of the Melbourne-Adelaide test, the availability performance of the Melbourne-Perth data loop cannot be readily estimated from availability information obtained for broadband bearers. As noted earlier, in the Melbourne-Perth test, a sizeable number of error-second outages (ESO) was suspected to occur in the Russell-Lonsdale-Clayton section. Table 7(d) summarizes the overall unavailability-related results on a weekly basis excluding the test days in which the previous impairments and the planned withdrawal of the Adelaide-Perth section were encountered. Unavailability of the Melbourne-Perth data test circuit was dominated by frequent short interruptions and sustained using bearer conditions. This is reflected in the large ratio (109 ÷ 1) of total duration of ESO to total duration of all carrier failures lasting 10 or more seconds individually. In addition, the total duration of ESO is found to be about 86 times the total duration of analogue interruptions for the test period considered. Note that the corresponding factor for the Melbourne-Adelaide circuit (over a different test period) is 21.

b. Error Performance

As in the Melbourne-Adelaide test, no attempt is made to compare in detail the data error performance and SA broadband bearer performance results. Similar conclusions are drawn for the Melbourne-Perth data circuit. The error performance was significantly degraded for test periods containing interruption and noise activities as monitored by the SA Administration.

5. DISCUSSIONS

The results obtained in this series of data tests indicate that the Melbourne-Adelaide 72 kbit/s groupband loop (about 1500 km looped and with 3 through-group filters) performed reasonably well between 8.3.79 and 4.4.79 both in availability and error performances. The DDN proposed availability objective of 99.98% (for long-haul segment) was close to being met. The DDN long-term error performance objective of 99.55% error-free seconds (EFS) (for long-haul segment) was met and the short-term objective of 99.1% EFS (for long-haul segment) was achieved for a large percentage (greater than 97% on the average) of 15-minute intervals.

On the other hand, the availability and long-term error performances of the Melbourne-Perth test data loop (about 6800 km looped and five through-group filters) could be described as fair between 8.1.79 and 4.3.79 and did not meet the DDN proposed objectives which assume a reference route distance of 2500 km. The short-term error performance was found to be rather poor : only a very small percentage (less than 5% on the average) of 15-minute intervals had a

performance better than 99.1% EFS. A sensitivity analysis also reveals that less than 70% of 15-minute intervals were satisfactory if the objective level was reduced from 99.1% EFS to 90% EFS (Fig. 3).

A close look at the bearer interruption activity monitored by the South Australian Administration indicates that there was nearly twice as much activity in the Adelaide-Perth section as in the Melbourne-Adelaide segment, leaving aside the planned outage in the former section. It is interesting to note that during the Melbourne-Adelaide data test (over a different and shorter period) the total duration of bearer interruptions is only one-tenth of the corresponding value during the Melbourne-Perth test. The data performance results described in this report should not therefore be assumed for other time periods. Nevertheless, they provide a useful appreciation of the relative performance of the tested groupband loops. The present overall error performance 72 kbit/s results are consistent with those previously obtained at 48 kbit/s with CCITT-V.35 compatible data modems (Ref. 1), although no error-second outages were included. It is conjectured that the point-to-point performance of these circuits will be in agreement with the remarks made on the present test loops, i.e. the DDN proposed objectives are expected to be met on the Melbourne-Adelaide groupband circuit and not on the Melbourne-Perth circuit.

The tests also reveal that the availability performance of a DDN data circuit cannot be readily estimated from the availability information obtained for broadband bearers. Frequent short interruptions and/or sustained noisy activities lead to error-second outages which dictate the availability of a data circuit. Under these conditions, specialized monitoring equipment like the Transmission Systems Branch data test set may be required in order to measure the availability performance. On the other hand, long interruptions are easily detected and can therefore be significantly reduced using appropriate patching procedures.

6. CONCLUDING REMARKS

The tests conducted on two microwave radio 72 kbit/s groupband data loops show that the Melbourne-Adelaide route via Bordertown met the DDN proposed availability and error performance objectives between 8.3.79 and 4.4.79 and that the Melbourne-Perth performance between 8.1.79 and 4.3.79 fell short of these objectives. But it must be remembered that the Perth loop has a distance more than twice the maximum distance specified by the DDN objectives. The error performance results are found to be consistent with the observations made on a previous series of tests conducted at 48 kbit/s and with a different line signal (CCITT-V.35 Recommendation).

The present test results however should not be generalized to cover other time periods because of the seasonal variations in performance of broadband radio bearers. Also, they should not be assumed when other groupband data modems compatible with CCITT-V.36 Recommendation are used. More importantly, the availability of a DDN data circuit should not be estimated from broadband bearer performance records unless some knowledge is obtained on the significance of error-second outages on that circuit.

It is hoped to conduct some point-to-point data tests in the future and to repeat the performance analysis as described in this report.

7. ACKNOWLEDGEMENTS

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APPENDIX A : SUMMARY OF DDN PROPOSED PERFORMANCE OBJECTIVES

1. OVERALL AVAILABILITY PERFORMANCE OBJECTIVES

1.1 The performance objectives below constitute the long-term targets for DDN services with a route distance up to and including 2500 km (see also Note 1).

1.2 All services will have an availability of better than 99.9% in any 12-month period.

1.3 The longest duration of an outage shall not exceed 4 hours in any 12-month period for all services.

1.4 The service is regarded as unavailable when 10 or more consecutive error-seconds are encountered.

NOTE 1: For services longer than 2500 km, a lower availability figure is acceptable.

2. OVERALL ERROR PERFORMANCE OBJECTIVES

2.1 The performance objectives below constitute the design objectives for DDN services with a route distance up to and including 2500 km (see also Note 2).

2.2 Long-term performance : equal to or better than 99.5% error-free seconds (EFS) over any 12-month period.

2.3 Short-term performance : for x%* of 15-minute intervals in any 12-month period, the performance in each interval shall be equal to or better than 99% error-free seconds.

2.4 The service is regarded as unavailable when 10 or more consecutive error-seconds are encountered.

* Due to the lack of test data, assignment of a numerical value to the factor "x" is deferred. The value of "x" will be set to be consistent with the performance measured during the proposed data transmission tests.

NOTE 2: For services longer than 2500 km a lower percentage of error-free seconds is acceptable.

NOTE 3: The following error-second allowance is adopted:

- 1 long-haul segment (2476 km) : 90%
- 2 metropolitan segments (16 km) : 5%
- 2 local segments (8 km) : 5%

3. SUMMARY TABLES

3.1 Long-Term (12 months) Availability and Error Performance Objectives

Parameter / Route Segment	% Availability	% Error-Free Seconds
Overall Route (2500 km)	99.90	99.50
Long-Haul Segment (2476 km)	99.98	99.55
Two Metropolitan Segments (16 km)	99.996	99.975
Two Local Segments (8 km)	99.94	99.975

3.2 Short-Term (15 minutes) Error Performance Objectives

Parameter / Route Segment	% Error-Free Seconds		
	T=15 Minutes	T=1 Hour (see note)	T=1 Day (see note)
Overall Route (2500 km)	99.00	99.00	99.50
Long-Haul Segment (2476 km)	99.10	99.10	99.55
Two Metropolitan Segments (16 km)	99.95	99.95	99.975
Two Local Segments (8 km)	99.95	99.95	99.975

Note: The short-term error performance objectives over T = 1 hour and T = 1 day are for Transmission Systems Branch use only.

APPENDIX B : SA BROADBAND PERFORMANCE MONITORING

As mentioned in the text, Trunk Service Section, Regional Operations Branch (SA) conducts tests on various broadband bearers to automatically monitor their performance (Ref. 3). Although the monitoring programme is (presently) designed for telephony purposes, it provides useful information such as interruption and noise activities which also affect data transmission. The system makes use of measuring devices known as Transmission Performance Testers (TPT) to monitor the following parameters:

- Interruption activities
- Level variations
- Mean noise power.

Any out-of-tolerance excursions of the above are logged in real time with the aid of a minicomputer. Performance objectives derived from the relevant Telecom Engineering Instructions and CCITT Recommendations are used.

For the purpose of this report, only a brief description of the SA performance parameters is given here. These are conveniently referred to as analogue performance parameters in contrast to data performance parameters. Two reference voiceband circuits representative of the bearer being monitored are used : the first or "tone channel" is on a loopback configuration and determines interruption activities and level variations, and the second is terminated at the distant end for noise measurements. The "tone channel" is chosen within a low-priority group while the "noise channel" is in the highest available supergroup or 15-supergroup assembly.

a. Interruption Activities. A 2 kHz tone of -10 dBm0 is used to monitor these activities. An interruption is an event which corresponds to a level drop of 6 dB or more. The detection circuitry for this parameter has a resolution of 1 ms, a deadtime of 2 ms and a hysteresis of 2 dB. Interruptions are classified into 5 categories according to their duration, namely:

Category 1 : 1 ms - 3 ms
Category 2 : 3 ms - 30 ms
Category 3 : 30 ms - 300 ms
Category 4 : 300 ms - 5 s
Category 5 : Greater than 5s

Events in Category 5 trigger an alarm and the time of occurrence is accordingly recorded.

b. Level Variations. These are recorded whenever the level of the above 2 kHz test tone goes beyond $\pm$ 2 dB from nominal. As this parameter is more sensitive than the previous interruption event, it is suppressed during interruption activites. However, if level variations persist for more than 5 minutes, an alarm is raised and the time of occurrence is accordingly recorded.

c. Noise Activities. The background noise in the second test voiceband channel is psophometrically measured using a 600 ohm termination and an integration time of 1 minute. Two parameters are evaluated. The first is circuit length dependent and a threshold is set at 3 pWop/km. The other is independent of distance and the associated threshold is 50,000 pWop. If these noise parameters exceed the corresponding threshold levels for more than a certain duration (5 minutes and 2 minutes, respectively), an alarm is raised and the time of occurrence is accordingly recorded.

	TEST ROUTE		BEARER	15-SGA NO	SUPERGROUP NO	GROUP NO	MULTIPLEX CIRCUIT DESIGNATION
DATA PERFORMANCE (RESEARCH, HQ)	MELBOURNE-ADELAIDE (via Bordertown) Loop Distance: 1512 km 8.3.79-4.4.79 (4 wks)		SV602	-	8	2	M-ADET-RUSC-E01/8 cross connected to M-LONC-RUSC-C21/1/8/2 with extension to Clayton Labs.
	MELBOURNE-PERTH Loop Distance: 6768 km 8.1.79-4.3.79 (8 wks)	M-A	As Above				As Above
		A-P	WS601	-	9	2	M-PRTC-ADET-E01/9/2
ANALOGUE PERFORMANCE (SA)	MELBOURNE-ADELAIDE (via Bordertown)		SV602	-	16	5	M-ADET-RUSC-E01/16/5 CH 11 — Tone Level CH 12 — Noise Level
	ADELAIDE-PERTH		WS601	-	9	1	M-PRTC-ADET-E01/9/1 CH 7 — Tone Level CH 8 — Noise Level

Table 1 Details of Data Test Circuits (Research, HQ) and Analogue Test Circuits (SA)

Note: Three through-group filters are used on the Adelaide loop while five filters are used on the Perth loop.

MELBOURNE-ADELAIDE(LOOPED) SEMATRANS MODEM 72KBIT/S				% OF TIME INTERVALS (T) FOR WHICH ERROR PERFORMANCE OBJECTIVE WAS MET ($)		
WEEKLY PERIOD	% VALID TIME	% AVAILA-BILITY	% ERROR-FREE SECONDS	T=15 MIN	(*) T=1 HOUR	(*) T=1 DAY
8/ 3/79 - 14/ 3/79	98.36	99.96	99.89	97.86	98.75	99.96
15/ 3/79 - 21/ 3/79	99.70	99.89	99.83	95.34	95.77	99.89
22/ 3/79 - 28/ 3/79	100.00	99.97	99.91	97.90	97.60	99.97
29/ 3/79 - 4/ 4/79	90.33	99.98	99.91	97.69	98.67	99.98

($)... IN THIS CALCULATION, ANY INTERVALS CONTAINING ERROR-SECOND OUTAGES ARE WEIGHTED ACCORDING TO THEIR AVAILABILITY PERCENTAGES.
(*)... FOR TRANSMISSION BRANCH USE ONLY.

Table 2 Availability and Error Performances of Melbourne-Adelaide 72 kbit/s Data Loop (8.3.79 - 4.4.79)

Table 2

WEEKLY PERIOD	MEDIAN BEC/ES (Bit Errors)	MEDIAN EFSR (Seconds)
8.3.79 - 14.3.79	24	768
15.3.79 - 21.3.79	48	384
22.3.79 - 28.3.79	12	768
29.3.79 - 4.4.79	12	768
OVERALL MEDIAN	24	672

Table 3 Median Bit Error Count per Error-Second (BEC/ES) and Median Error-Free-Second Run (EFSR) for Melbourne-Adelaide 72 kbit/s Data Loop (8.3.79 - 4.4.79)

DAY	DATE	DURATION (sec)				REMARKS
		ERROR-SECOND OUTAGES	CARRIER FAILURES	CARRIER FAILURES (≥10 sec)	ANALOGUE INTERRUPTIONS (SA Record)	
67	Mar 8	0	0.92	0	0.79	
68	9	15	0.92	0	0.65	
69	10	75	0.27	0	0.21	
70	11	85	0.78	0	0.61	
71	12	43	0.32	0	0.23	
72	13	0	10.62	0	18.57	Note 1
73	14	0	0	0	1.75	Note 1
74	Mar 15	0	1.28	0	0.53	
75	16	0	0.30	0	0.27	
76	17	368	0.32	0	0.19	
77	18	0	0.15	0	0.09	
78	19	0	4.20	0	3.90	
79	20	298	6.35	0	6.19	
80	21	0	0.07	0	0.04	

Table 4(a) Comparison of Unavailability-Related Results for Melbourne-Adelaide 72 kbit/s Data Loop.
Period : 8.3.79 - 21.3.79

Note:

1. Data test period contains invalid intervals.

DAY	DATE	DURATION (sec)				REMARKS
		ERROR-SECOND OUTAGES	CARRIER FAILURES	CARRIER FAILURES (≥10 sec)	ANALOGUE INTERRUPTIONS (SA Record)	
81	Mar 22	0	0.27	0	0.25	
82	23	21	0.16	0	0.13	
83	24	41	0	0	0.01	
84	25	0	0.05	0	0.03	
85	26	52	0	0	0	
86	27	80	10.87	0	9.49	
87	28	0	0	0	0	
88	Mar 29	102	18.76	0	7.87	Note 1
89	30	0	0	0	0.06	
90	31	0	0	0	0	
91	Apr 1	0	0	0	0	
92	2	0	0	0	0	
93	3	0	0	0	0	
94	4	0	0	0	0	

Table 4(b) Comparison of Unavailability-Related Results for Melbourne-Adelaide 72 kbit/s Data Loop
Period : 22.3.79 - 4.4.79

Note:

1. Unlocated fault in Victorian section.

WEEKLY PERIOD	DURATION (sec)			
	ERROR-SECOND OUTAGES	CARRIER FAILURES	CARRIER FAILURES (≥10 sec)	ANALOGUE INTERRUPTIONS (SA Record)
8.3.79 - 14.3.79	218	13.83	0	22.81
15.3.79 - 21.3.79	666	12.67	0	11.21
22.3.79 - 28.3.79	194	11.35	0	9.91
29.3.79 - 4.4.79	102	18.76	0	7.93
TOTAL	1180	56.61	0	51.86

Table 4(c) Comparison of Unavailability-Related Results for Melbourne-Adelaide 72 kbit/s Data Loop. Summary for Period : 8.3.79 - 4.4.79

MELBOURNE-PERTH(LOOPED) SEMATRANS MODEM 72KBIT/S				% OF TIME INTERVALS (T) FOR WHICH ERROR PERFORMANCE OBJECTIVE WAS MET (\$)		
WEEKLY PERIOD	% VALID TIME	% AVAILA-BILITY	% ERROR-FREE SECONDS	T=15 MIN	(*) T=1 HOUR	(*) T=1 DAY
8/ 1/79 - 14/ 1/79	93.60	96.27	87.41	0.95	0.16	0.
15/ 1/79 - 21/ 1/79	99.55	89.91	80.30	0.30	0.	0.
22/ 1/79 - 28/ 1/79	84.67	94.77	88.45	4.22	2.11	0.
29/ 1/79 - 4/ 2/79	94.79	96.59	89.65	7.54	5.02	0.
5/ 2/79 - 11/ 2/79	58.93	96.54	91.38	3.28	0.	0.
12/ 2/79 - 18/ 2/79	40.92	99.22	93.58	12.36	8.36	0.
19/ 2/79 - 25/ 2/79	96.28	96.56	90.14	0.	0.	0.
26/ 2/79 - 4/ 3/79	70.68	97.33	91.01	8.00	7.58	0.

(\$)... IN THIS CALCULATION, ANY INTERVALS CONTAINING ERROR-SECOND OUTAGES ARE WEIGHTED ACCORDING TO THEIR AVAILABILITY PERCENTAGES.
(*)... FOR TRANSMISSION BRANCH USE ONLY.

Table 5 Availability and Error Performances of Melbourne-Perth 72 kbit/s Data Loop (8.1.79 - 4.3.79)

WEEKLY PERIOD	MEDIAN BEC/ES (Bit Errors)	MEDIAN EFSR (Seconds)
8.1.79 - 14.1.79	3	3
15.1.79 - 21.1.79	6	1
22.2.79 - 28.1.79	3	3
29.2.79 - 4.2.79	3	3
5.2.79 - 11.2.79	3	6
12.2.79 - 18.2.79	3	6
19.2.79 - 25.2.79	3	6
26.2.79 - 4.3.79	6	6
OVERALL MEDIAN	4	4

Table 6 Median Bit Error Count per Error-Second (BEC/ES) and Median Error-Free-Second Run (EFSR) for Melbourne-Perth Data Loop (8.1.79 - 4.3.79).

DAY	DATE	DURATION (sec)				REMARKS
		ERROR-SECOND OUTAGES	CARRIER FAILURES	CARRIER FAILURES (≥10 sec)	ANALOGUE INTERRUPTIONS (SA Record)	
8	Jan 8	63	1.02	0	0.40	
9	9	70	1.31	0	0.66	
10	10	1243	410.39	373.55	408.50	Note 1
11	11	6909	5.80	0	4.46	
12	12	12681	1231.29	1076.16	6.85	Note 2
13	13	1125	0.69	0	0.29	
14	14	232	0.79	0	0.28	
15	Jan 15	4523	0.88	0	0.09	
16	16	1095	1.63	0	0.35	
17	17	39186	0.14	0	0.05	Note 2
18	18	5887	115.11	110.09	113.06	Note 3
19	19	8397	72.40	65.80	71.35	Note 4
20	20	1640	0.82	0	0.50	
21	21	1870	0.42	0	0.19	

Table 7(a) Comparison of Unavailability-Related Results for Melbourne-Perth 72 kbit/s Data Loop. Period : 8.1.79 - 21.179

Notes:

1. No-break power failure at Surrey Hills (Vic)
2. Unavailability of data circuit suspected to occur mainly in Russell-Lonsdale-Clayton section (Vic)
3. Faulty switching in Pier-Northam section (WA)
4. Faulty switching at Caiguna (WA)

DAY	DATE	DURATION (sec)				REMARKS
		ERROR-SECOND OUTAGES	CARRIER FAILURES	CARRIER FAILURES (≥10 sec)	ANALOGUE INTERRUPTIONS (SA Record)	
22	Jan 22	122	0.17	0	0.08	
23	23	15629	1.50	0	11.35	Note 1
24	24	12227	189.00	169.32	89.57	Note 2
25	25	0	0.04	0	12.46	Notes 3 & 4
26	26	0	0	0	0.23	Note 4
27	27	0	0.12	0	0.05	
28	28	590	2.03	0	1.34	
29	Jan 29	3815	17.17	0	4.27	
30	30	3743	3683.35	3677.35	3685.03	Note 5
31	31	14457	6538.82	6532.53	53.82	Note 6
32	Feb 1	8265	35.40	27.78	30.13	
33	2	1764	1.99	0	1.06	
34	3	0	0.19	0	0.11	
35	4	0	0.15	0	0.09	

Table 7(b) Comparison of Unavailability-Related Results for Melbourne-Perth 72 kbit/s Data Loop. Period : 22.1.79 - 4.2.79

Notes:

1. Personnel-caused fault at Russell (Vic)
2. Unlocated fault
3. Fault at One Tree Hill (Vic)
4. Data test period contains invalid intervals
5. Planned bearer withdrawal (61 minutes) between Adelaide and Perth
6. Unavailability of data circuit suspected to occur mainly in Russell-Lonsdale-Clayton section (Vic)

DAY	DATE	DURATION (sec)				REMARKS
		ERROR-SECOND OUTAGES	CARRIER FAILURES	CARRIER FAILURES (≥10 sec)	ANALOGUE INTERRUPTIONS (SA Record)	
36	Feb 5	35	0.42	0	0.21	
37	6	1503	350.76	342.22	3.32	Note 1
38	7	26822	9591.43	3670.88	0.39	Note 1
39	8	11250	10583.03	10580.22	15.27	Notes 1 & 2
40	9	12569	6831.41	6798.35	12.00	Notes 1 & 3
41	10	-	-	-	-	Note 4
42	11	-	-	-	-	Note 4
43	Feb 12	-	-	-	-	Note 4
44	13	5871	5860.69	5824.63	9.34	Note 1
45	14	-	-	-	-	Note 4
46	15	-	-	-	-	Note 4
47	16	0	0.13	0	0.11	
48	17	1707	131.50	42.09	129.63	Note 5
49	18	25	9.39	0	8.76	

Table 7(c) Comparison of Unavailability-Related Results for Melbourne-Perth 72 kbit/s Data Loop. Period : 5.2.79 - 18.2.79

Notes:

1. Unavailability of data circuit suspected to occur mainly in Russell-Lonsdale-Clayton section (Vic)
2. No-break power fault at Mt Yokine (WA)
3. Fading between Tailem Bend and Mt Bonython
4. Invalid data test period
5. Fading in WA section.

DAY	DATE	DURATION (sec)				REMARKS
		ERROR-SECOND OUTAGES	CARRIER FAILURES	CARRIER FAILURES (≥10 sec)	ANALOGUE INTERRUPTIONS (SA Record)	
50	Feb 19	82	64.68	54.69	66.65	Note 1
51	20	6165	1.62	0	0.89	
52	21	636	0.60	0	25.84	Note 2
53	22	699	10.46	0	9.90	
54	23	8375	8.57	0	8.18	Note 3
55	24	3645	0.07	0	0.27	
56	25	417	128.63	38.06	112.74	Note 4
57	Feb 26	473	0.49	0	0.83	
58	27	48	0.77	0	3.63	
59	28	-	-	-	-	Note 5
60	Mar 1	-	-	-	-	Note 5
61	2	1792	21.00	17.94	47.42	Notes 2&6
62	3	6045	56.02	55.94	55.95	
63	4	3060	47.17	41.88	47.44	Note 7

Table 7(d) Comparison of Unavailability-Related Results for Melbourne-Perth 72 kbit/s Data Test Loop. Period : 19.2.79 - 4.3.79

Notes:

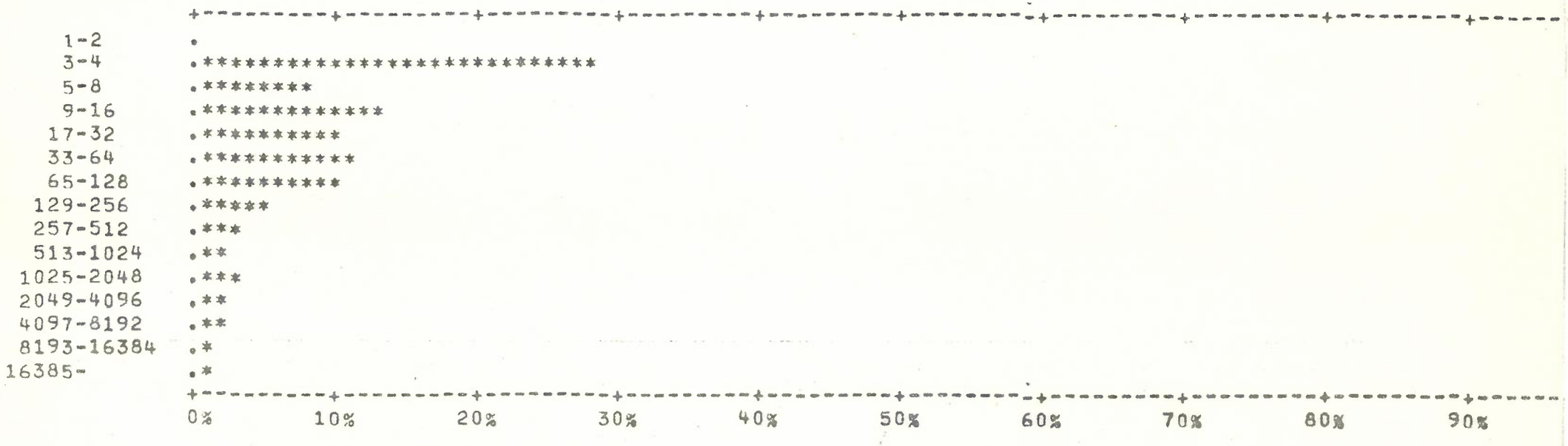
1. Fault in Victorian section
2. Data test period contains invalid intervals
3. Faulty switching in WA section
4. Unlocated fault
5. Invalid data test period
6. Fading between Surrey Hills and One Tree Hill (Vic)
7. No-break power failure at Pier (WA)

WEEKLY PERIOD	DURATION (sec)			
	ERROR-SECOND OUTAGES	CARRIER FAILURES	CARRIER FAILURES (≥10 sec)	ANALOGUE INTERRUPTIONS (SA Record)
8.1.79 - 14.1.79	9642	420.00	373.55	414.59
15.1.79 - 21.1.79	23412	191.26	175.89	185.54
22.1.79 - 28.1.79	28568	192.86	169.32	115.08
29.1.79 - 4.2.79	13844	54.90	27.78	35.66
5.2.79 - 11.2.79	35	0.42	0	0.21
12.2.79 - 18.2.79	1732	141.02	42.09	138.50
19.2.79 - 25.2.79	20019	214.63	92.75	224.47
26.2.79 - 4.3.79	11418	125.45	115.76	155.27
TOTAL	108 670	1340.54	997.14	1269.32

Table 7(e) Comparison of Unavailability-Related Results for Melbourne-Perth 72 kbit/s Data Loop. Summary for Period : 8.1.79 - 4.3.79.

Note: Test days containing the planned bearer withdrawal of the Adelaide-Perth section and suspected faults in Russell-Lonsdale-Clayton section have been excluded from this table.

MELBOURNE-ADELAIDE(LOOPED) SEMATRANS MODEM 72kBIT/S
DISTRIBUTION OF BIT ERROR COUNTS PER ERROR SECOND FOR THE PERIOD 8/ 3/79 - 14/ 3/79

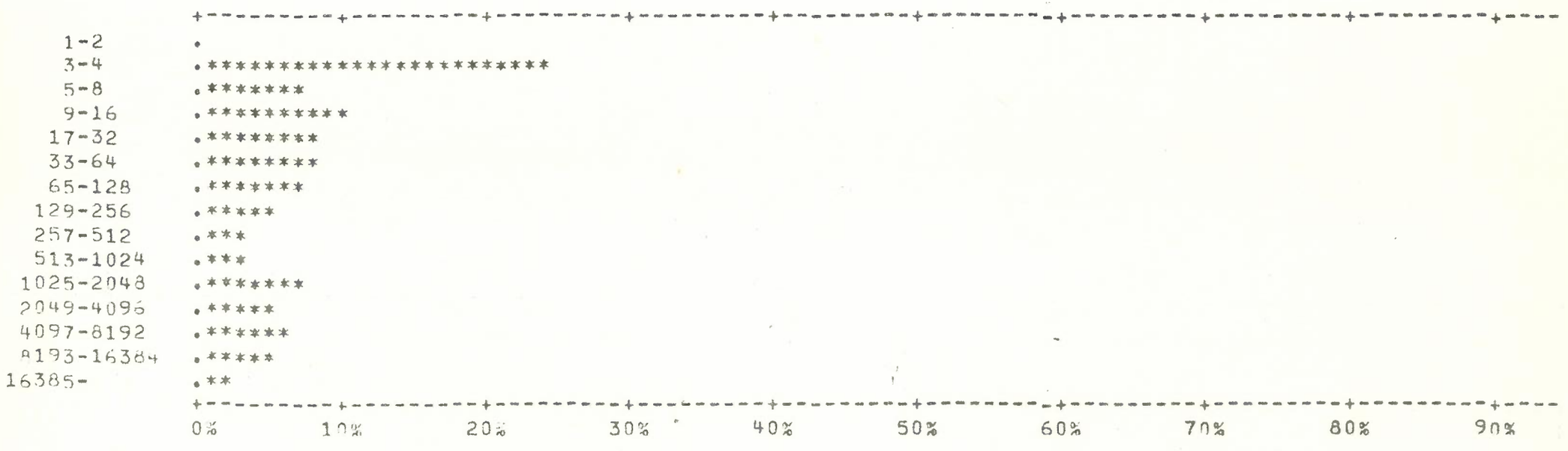


TOTAL NO. OF ERROR SECONDS = 891
TOTAL NO. OF AVAILABLE SECONDS = 594682
TOTAL NO. OF VALID SECONDS = 594900

Fig. 1(a) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Adelaide 72 kbit/s Data Loop. Period : 8.3.79 - 14.3.79

Fig. 1(a)

MELBOURNE-ADELAIDE(LOOPED) SEMATRANS MODEM 72KBIT/S
DISTRIBUTION OF BIT ERROR COUNTS PER ERROR SECOND FOR THE PERIOD 15/ 3/79 - 21/ 3/79

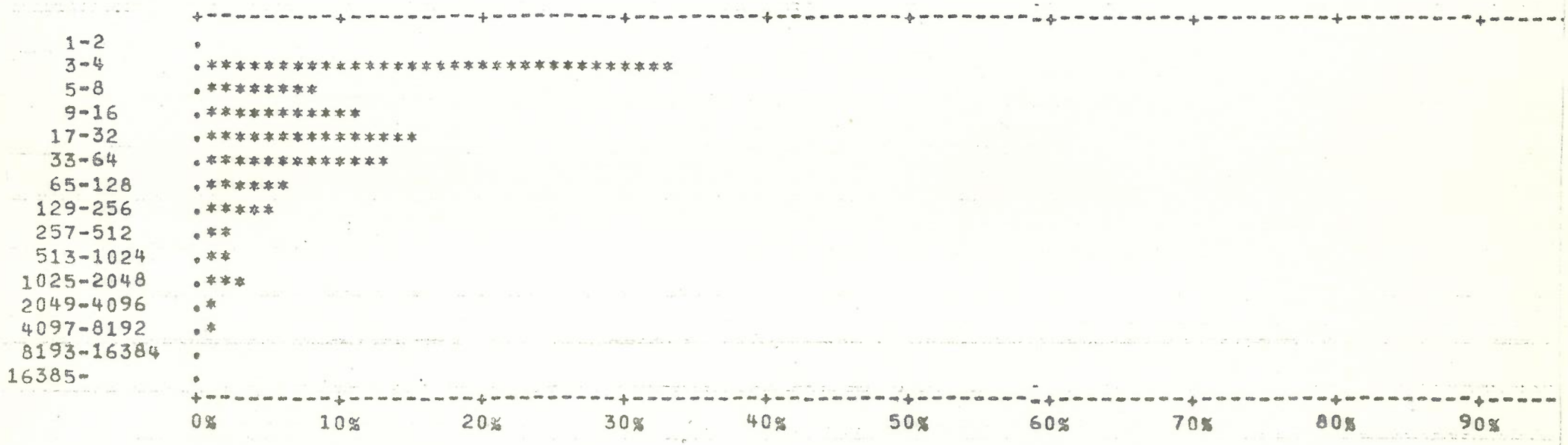


TOTAL NO. OF ERROR SECONDS = 1718
TOTAL NO. OF AVAILABLE SECONDS = 602334
TOTAL NO. OF VALID SECONDS = 603000

Fig. 1(b) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Adelaide 72 kbit/s Data Loop. Period : 15.3.79 - 21.3.79

Fig. 1(b)

MELBOURNE-ADELAIDE(LOOPED) SEMATRANS MODEM 72KBIT/S
DISTRIBUTION OF BIT ERROR COUNTS PER ERROR SECOND FOR THE PERIOD 22/ 3/79 - 28/ 3/79

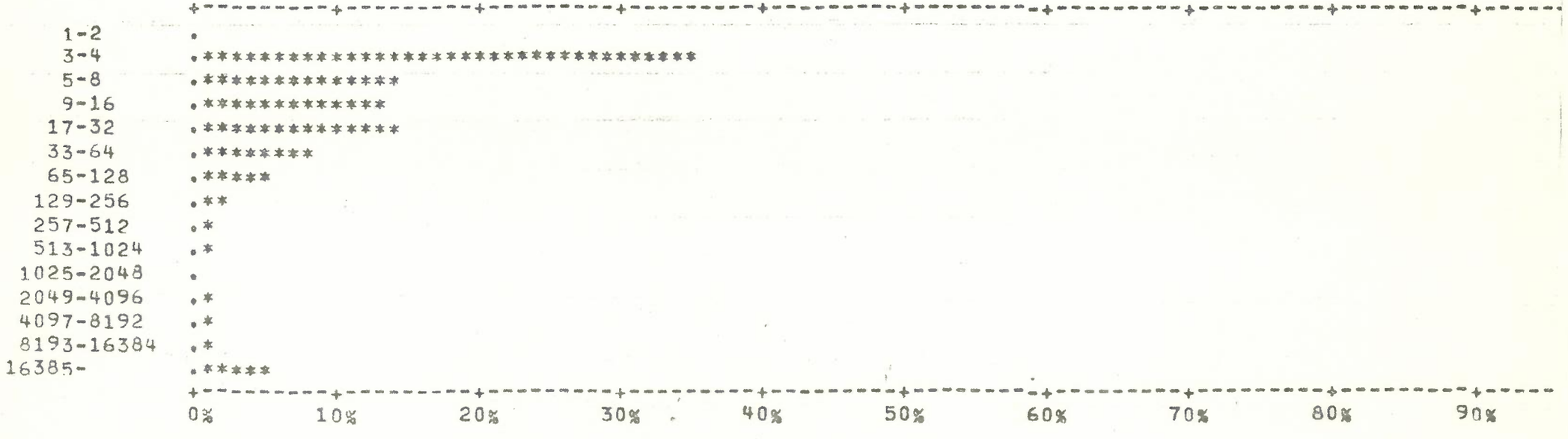


TOTAL NO. OF ERROR SECONDS = 728
TOTAL NO. OF AVAILABLE SECONDS = 604606
TOTAL NO. OF VALID SECONDS = 604800

Fig. 1(c) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Adelaide 72 kbit/s Data Loop. Period : 22.3.79 - 28.3.79

Fig. 1(c)

MELBOURNE-ADELAIDE(LOOPED) SEMATRANS MODEM 72kBIT/S
DISTRIBUTION OF BIT ERROR COUNTS PER ERROR SECOND FOR THE PERIOD 29/ 3/79 - 4/ 4/79



TOTAL NO. OF ERROR SECONDS = 618
TOTAL NO. OF AVAILABLE SECONDS = 546198
TOTAL NO. OF VALID SECONDS = 546300

Fig. 1(d) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Adelaide 72 kbit/s Data Loop. Period : 29.3.79 - 4.4.79

Fig. 1(d)

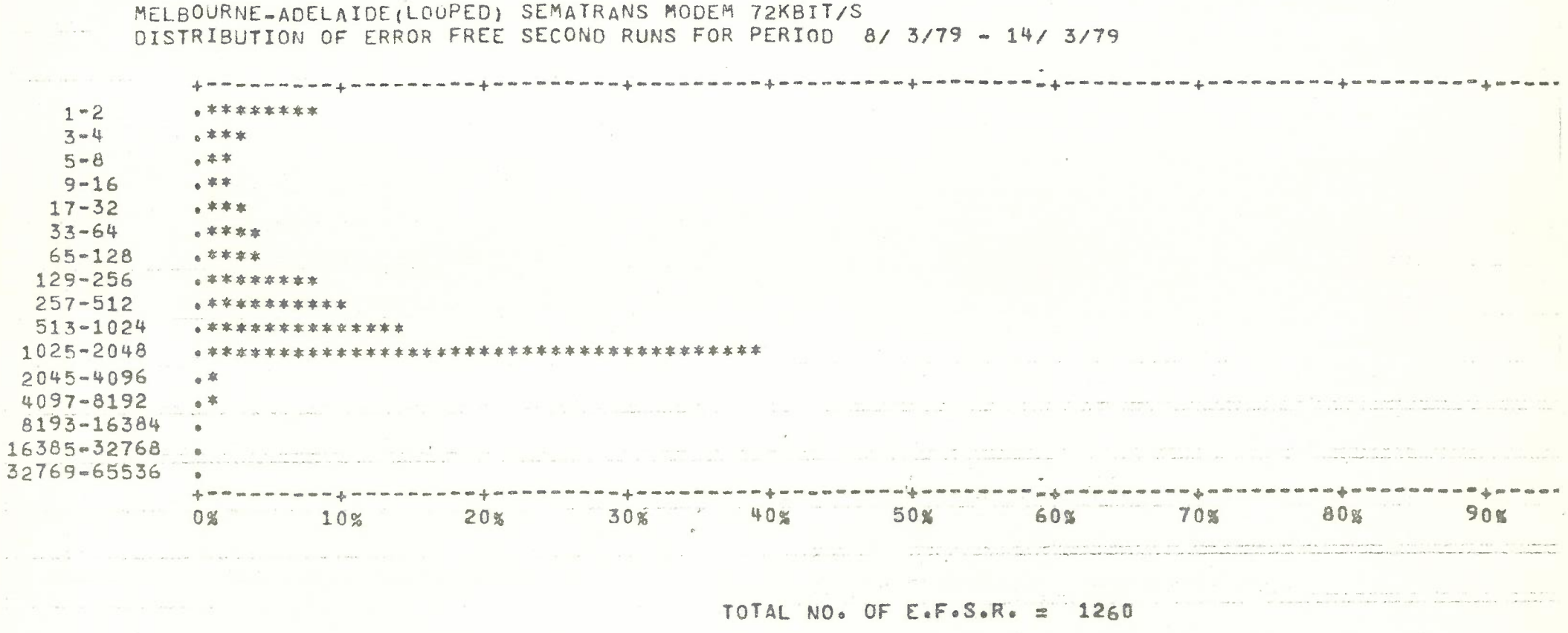


Fig. 2(a) Percentage Histogram of Error-Free-Second Runs for Melbourne-Adelaide 72 kbit/s Data Loop. Period : 8.3.79 - 14.3.79

Fig. 2(a)

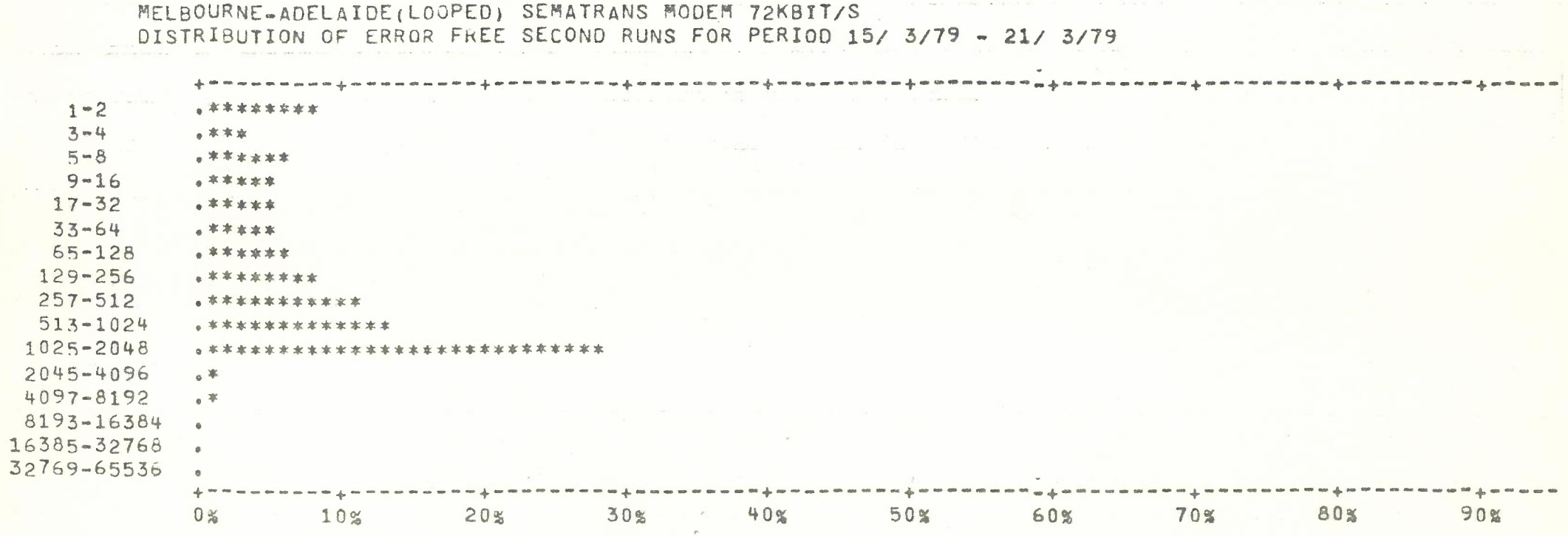


Fig. 2(b) Percentage Histogram of Error-Free-Second Runs for Melbourne-Adelaide 72 kbit/s Data Loop. Period : 15.3.79 - 21.3.79

Fig. 2(b)

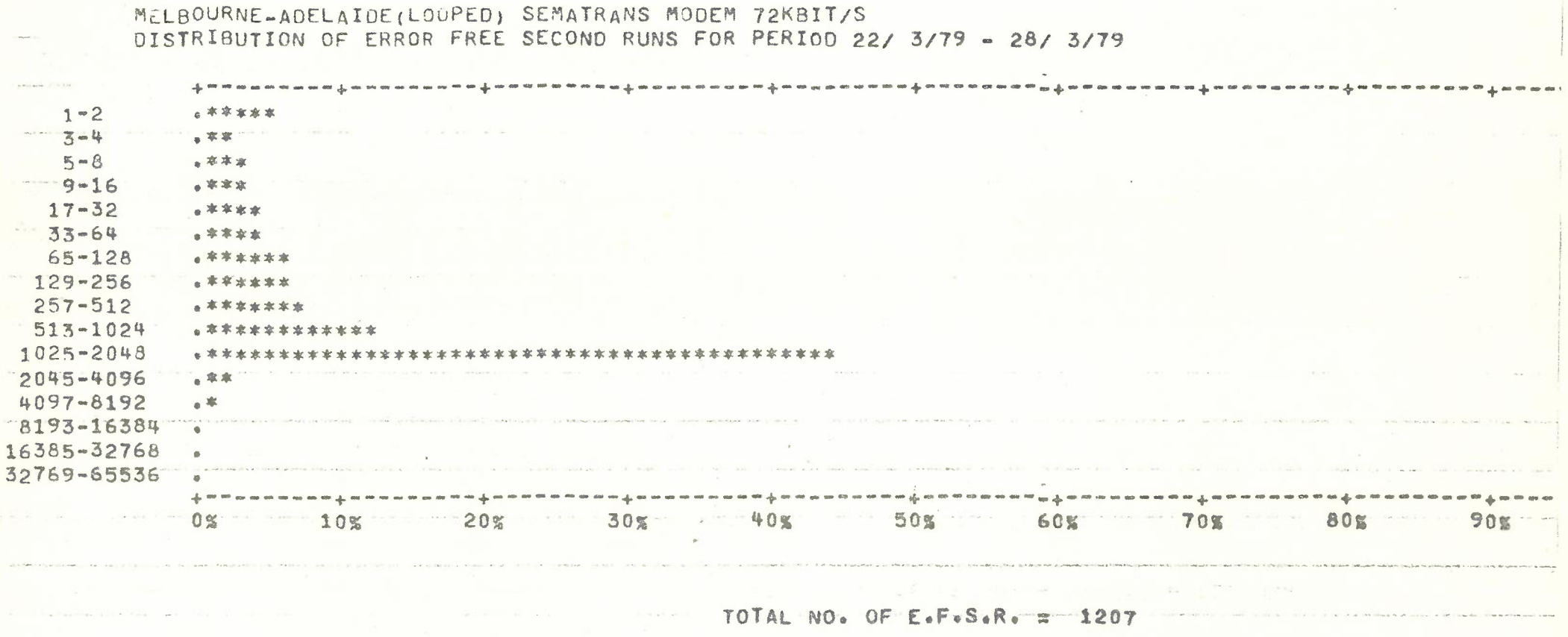


Fig. 2(c) Percentage Histogram of Error-Free-Second Runs for Melbourne-Adelaide 72 kbit/s Data Loop. Period : 22.3.79 - 28.3.79

Fig. 2(c)

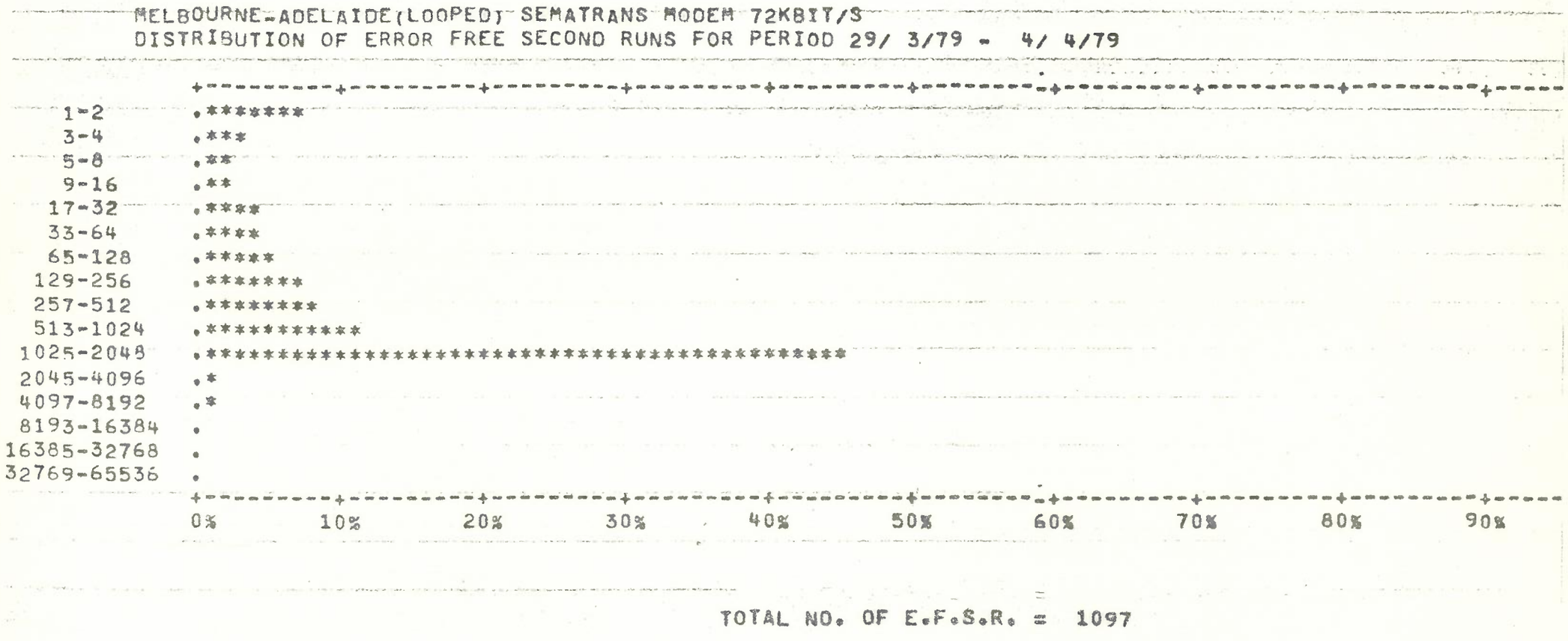
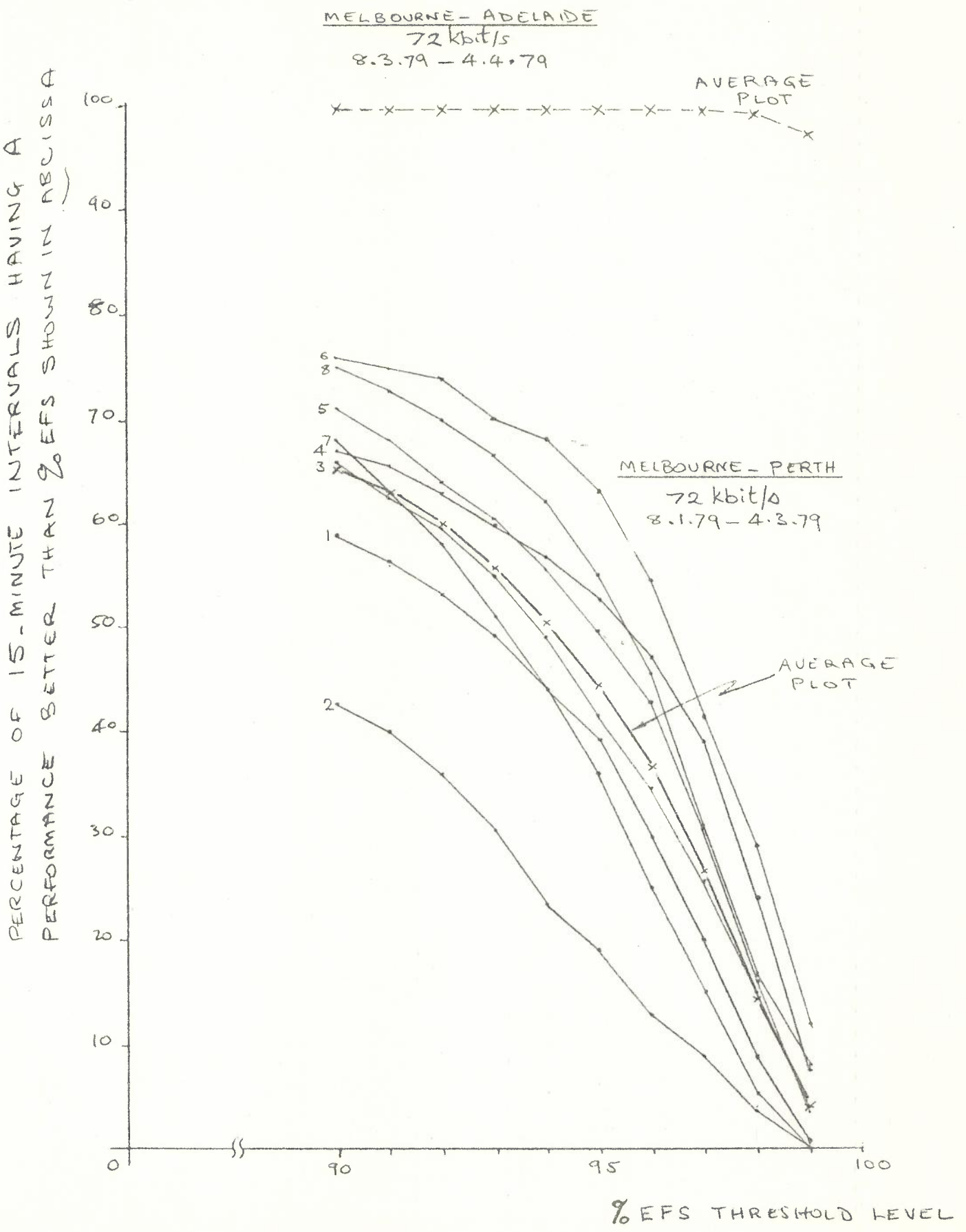


Fig. 2(d) Percentage Histrogram of Error-Free-Second Runs for Melbourne-Adelaide 72 kbit/s Data Loop. Period : 29.3.79 - 4.4.79

Fig. 2(d)

FIG. 3 SENSITIVITY ANALYSIS OF ERROR PERFORMANCE UNDER DIFFERENT % EFS THRESHOLD LEVELS



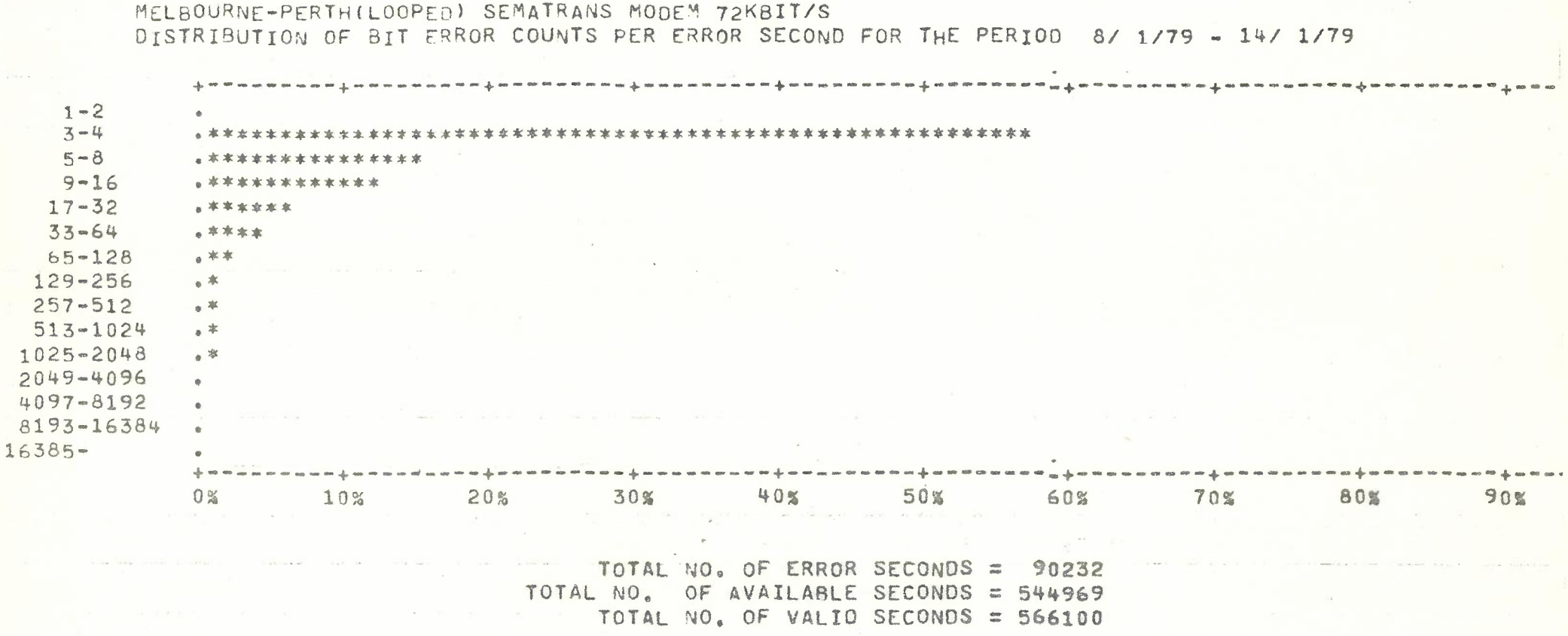


Fig. 4(a) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Perth 72 kbit/s Data Loop. Period : 8.1.79 - 14.1.79

Fig. 4(a)

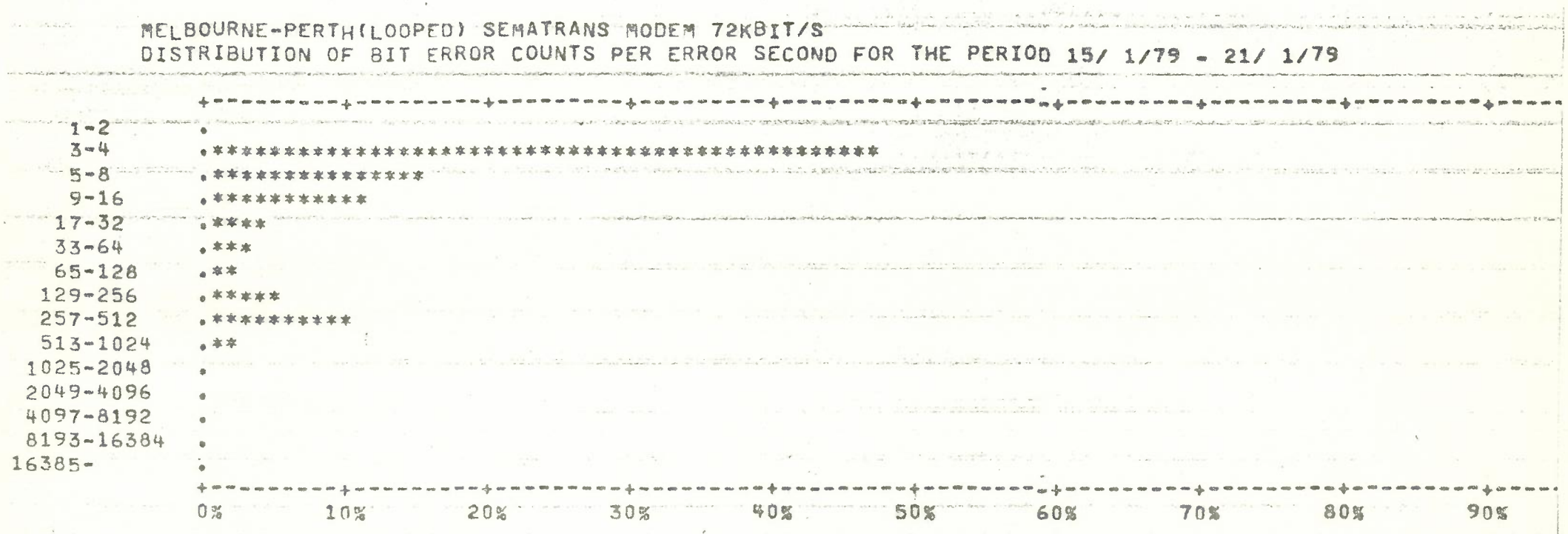


Fig. 4(b) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Perth 72 kbit/s Data Loop. Period : 15.1.79 - 21.1.79

Fig. 4(b)

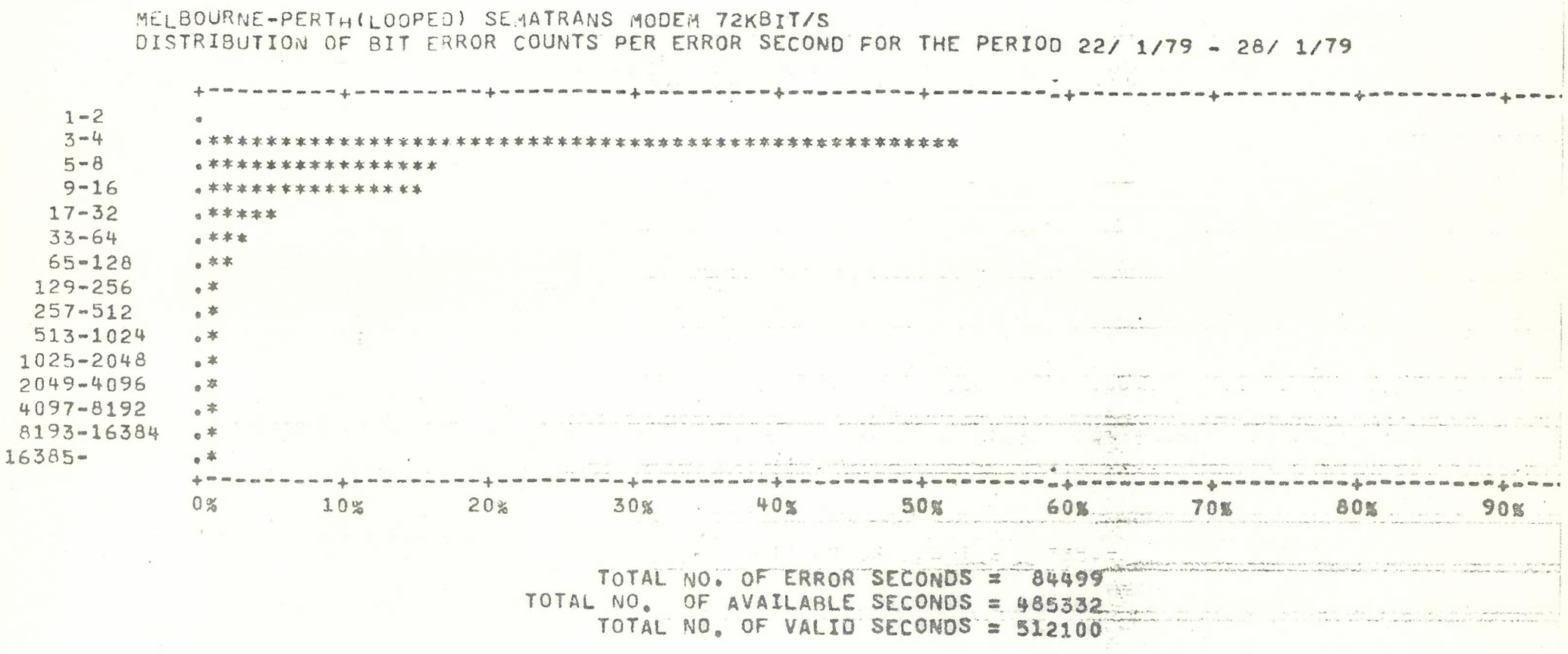


Fig. 4(c) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Perth 72 kbit/s Data Loop. Period : 22.1.79 - 28.1.79

Fig. 4(c)

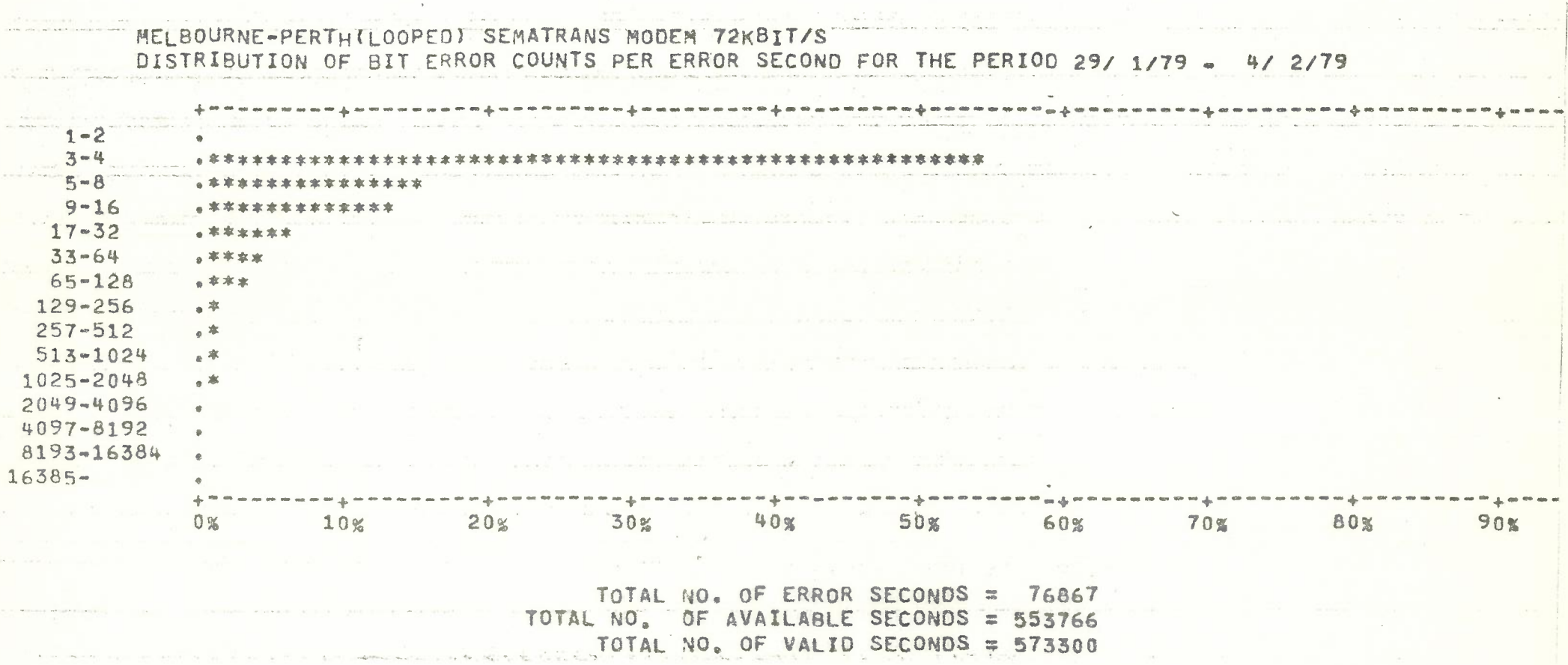


Fig. 4(d) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Perth 72 kbit/s Data Loop. Period : 29.1.79 - 4.2.79

Fig. 4(d)

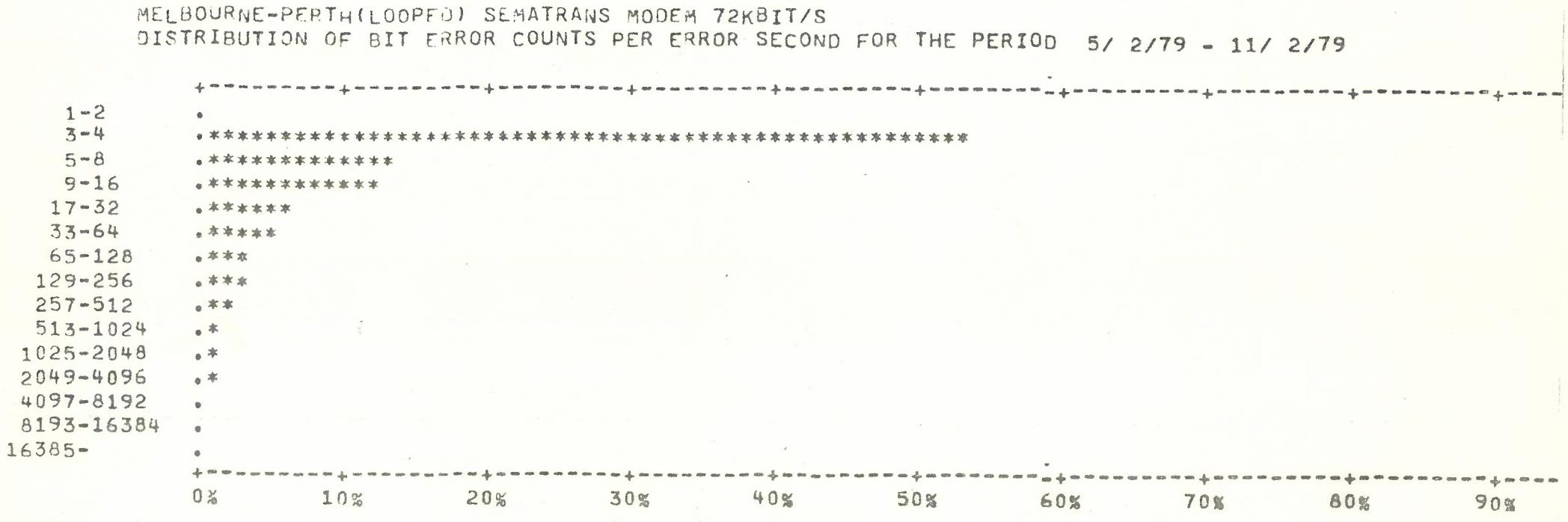


Fig. 4(e) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Perth 72 kbit/s Data Loop. Period : 5.2.79 - 11.2.79

Fig. 4(e)

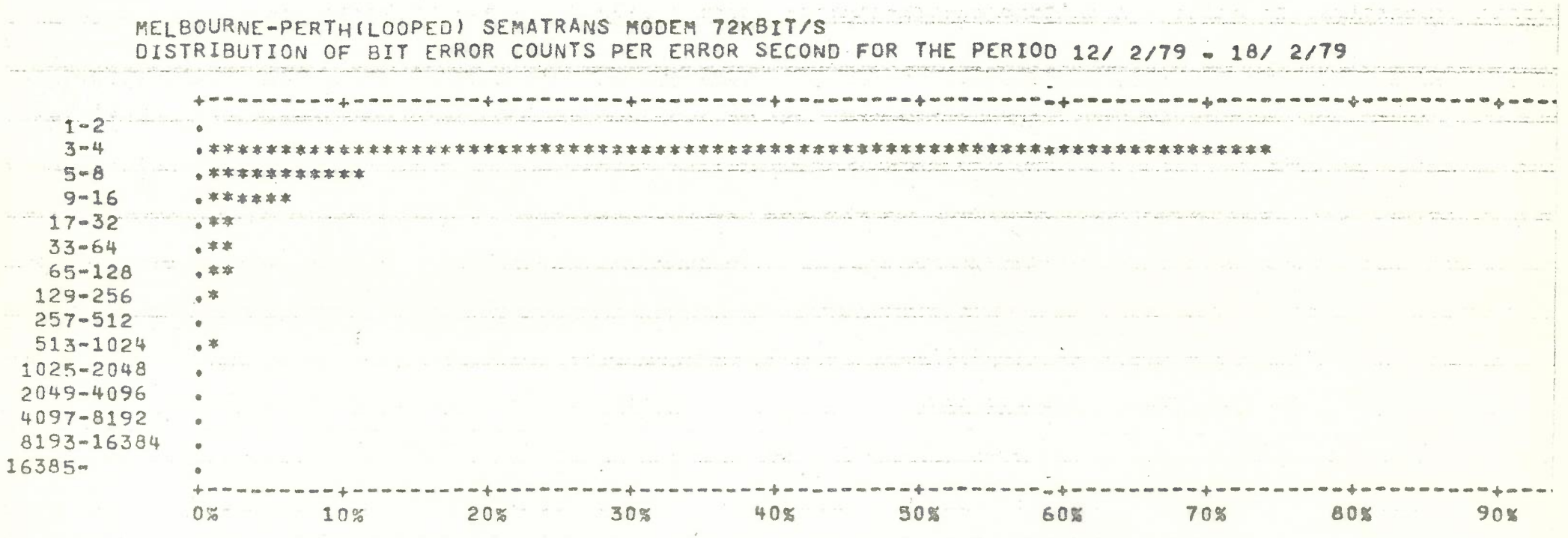


Fig. 4(f) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Perth 72 kbit/s Data loop. Period : 12.2.79 - 18.2.79

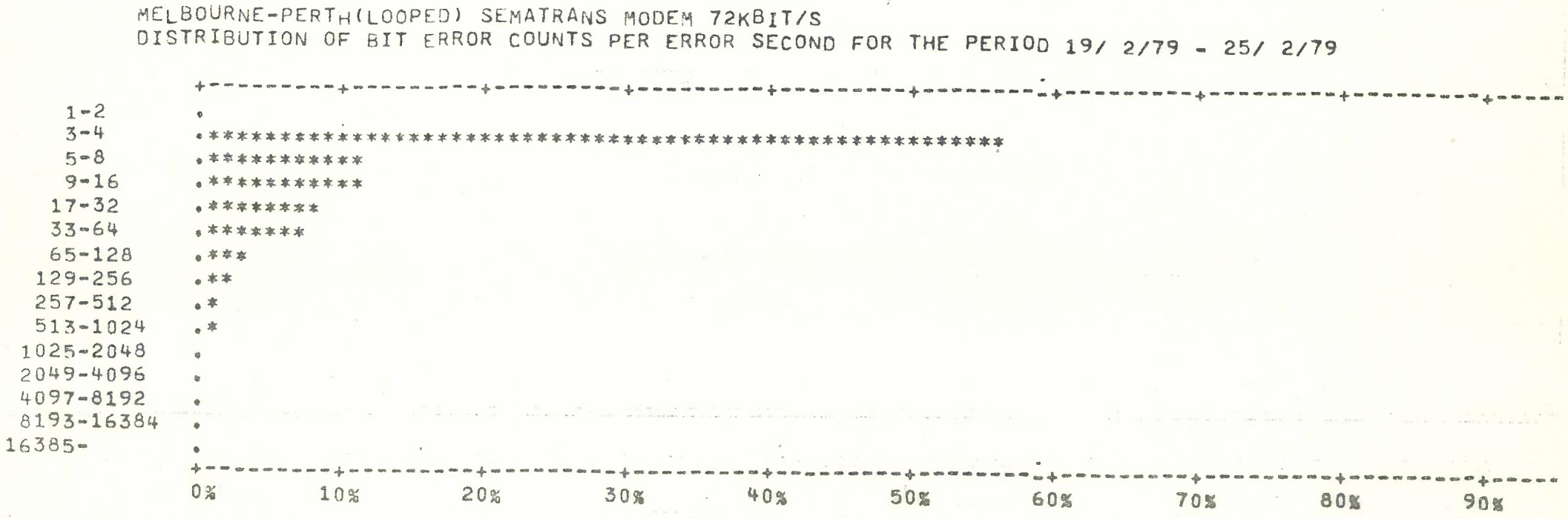
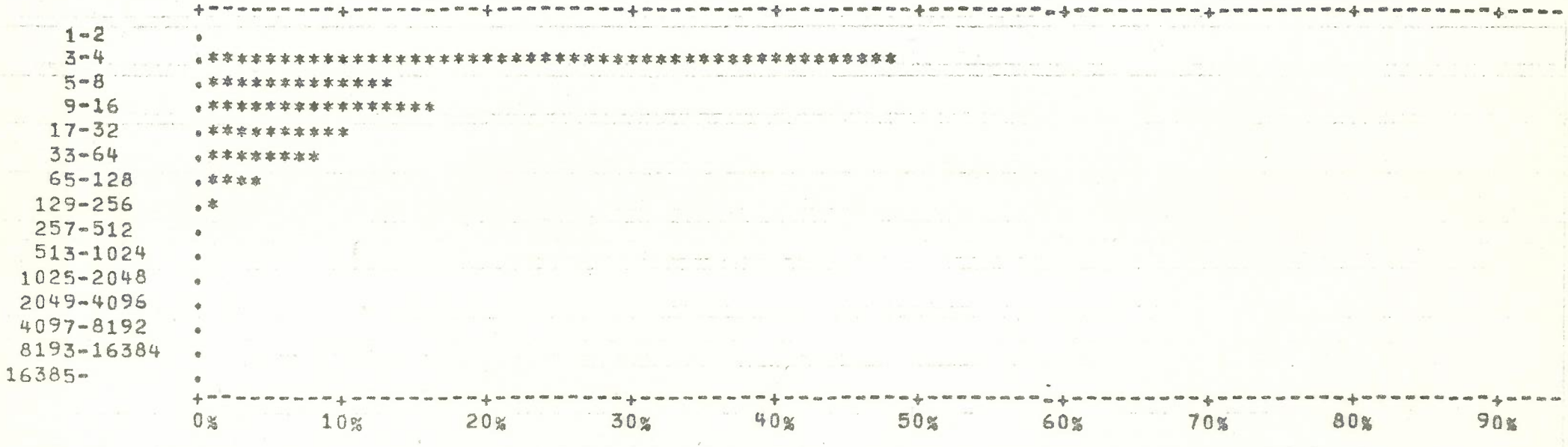


Fig. 4(g) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Perth 72 kbit/s Data Loop. Period : 19.2.79 - 25.2.79

Fig. 4(g)

MELBOURNE-PERTH(LOOPED) SEMATRANS MODEM 72KBIT/S
DISTRIBUTION OF BIT ERROR COUNTS PER ERROR SECOND FOR THE PERIOD 26/ 2/79 - 4/ 3/79



TOTAL NO. OF ERROR SECONDS = 48831
TOTAL NO. OF AVAILABLE SECONDS = 416079
TOTAL NO. OF VALID SECONDS = 427500

Fig. 4(h) Percentage Histogram of Bit Error Counts per Error-Second for Melbourne-Perth 72 kbit/s Data Loop. Period : 26.2.79 - 4.3.79

Fig. 4(h)

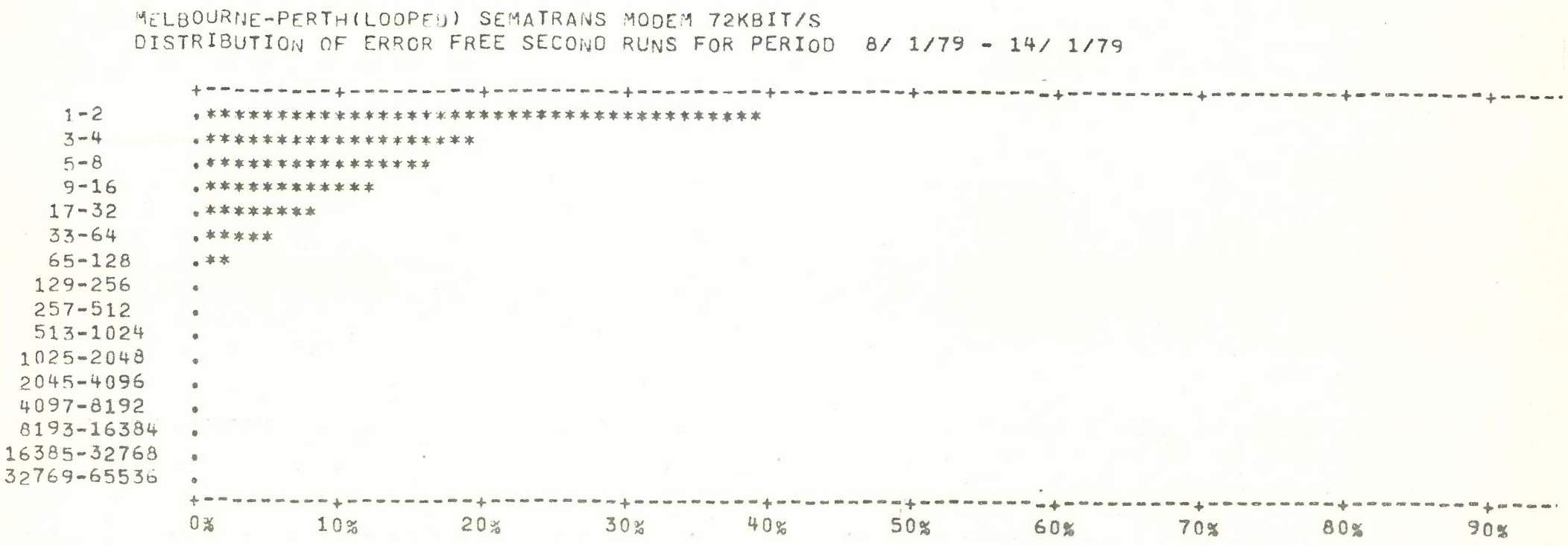


Fig. 5(a) Percentage Histogram of Error-Free-Second Runs for Melbourne-Perth 72 kbit/s Data Loop. Period : 8.1.79 - 14.1.79

Fig. 5(a)

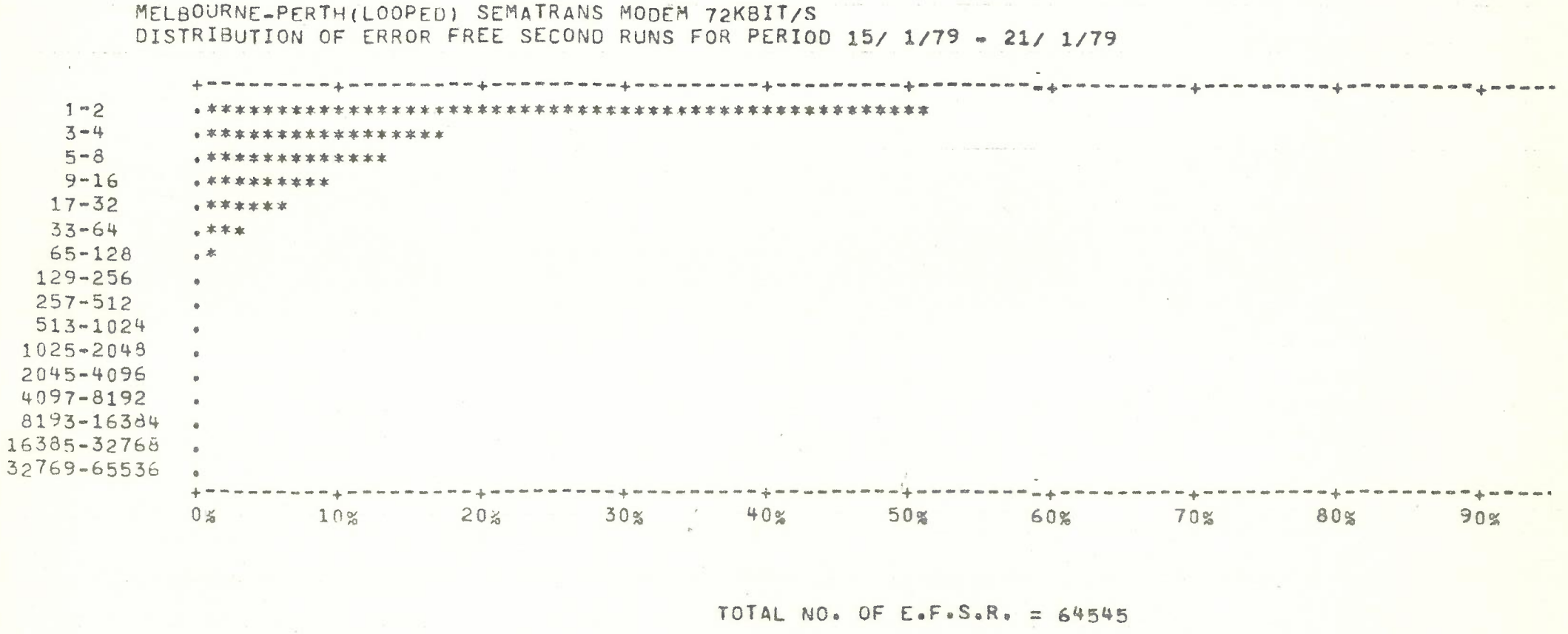


Fig. 5(b) Percentage Histogram of Error-Free-Second Runs for Melbourne-Perth 72 kbit/s Data Loop. Period : 15.1.79 - 21.1.79

Fig. 5(b)

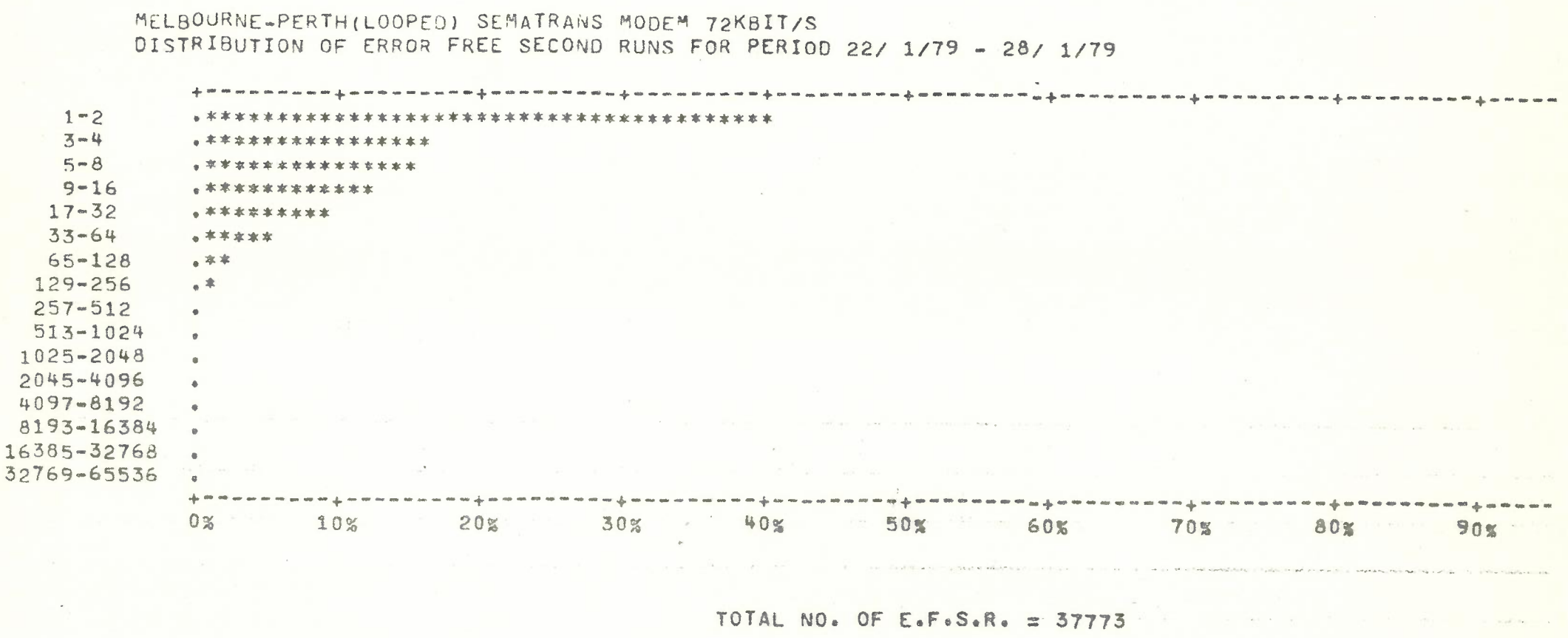


Fig. 5(c) Percentage Histogram of Error-Free-Second Runs for Melbourne-Perth 72 kbit/s Data Loop. Period : 22.1.79 - 28.1.79

Fig. 5(c)

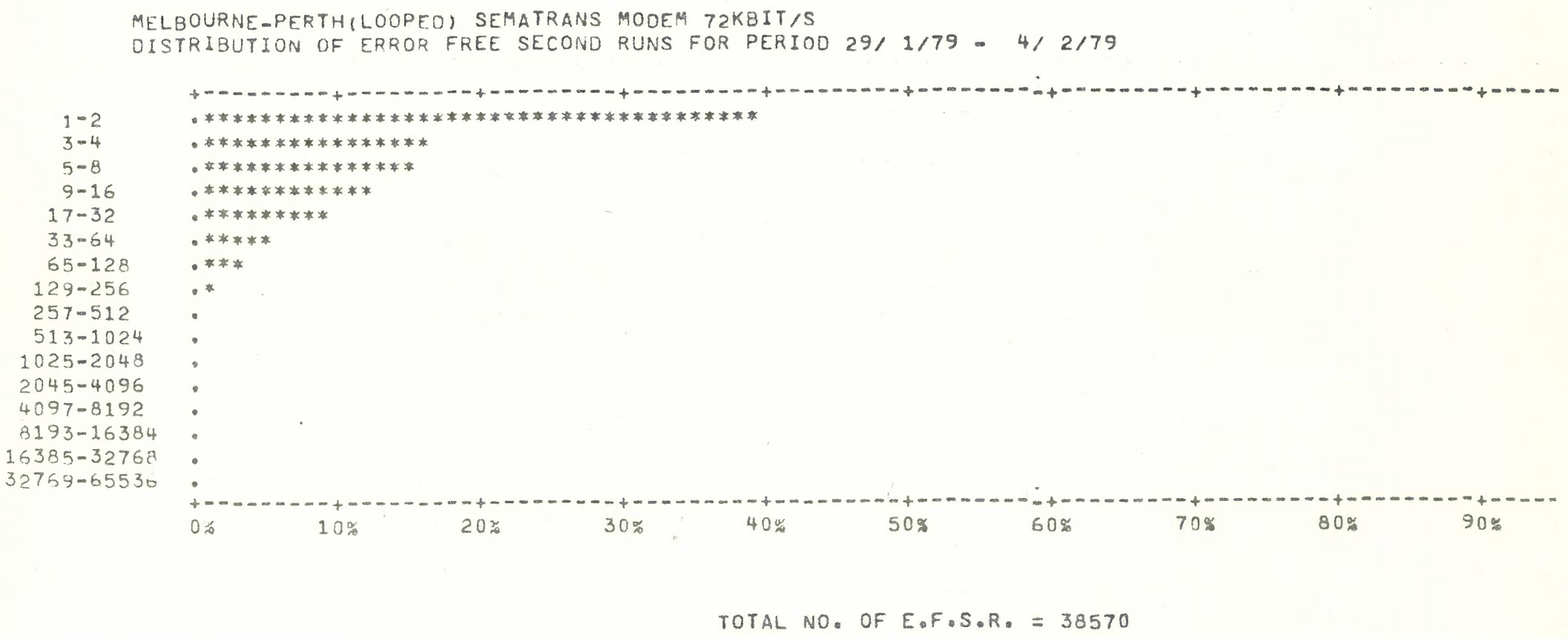
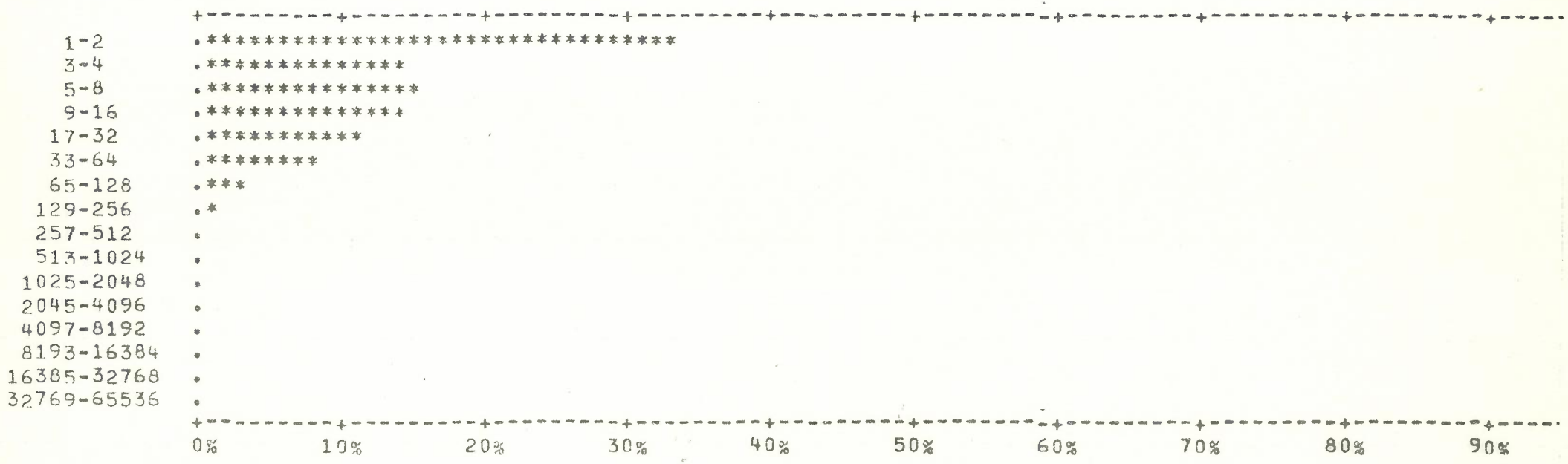


Fig. 5(d) Percentage Histogram of Error-Free-Second Runs for Melbourne-Perth 72 kbit/s Data Loop. Period : 29.1.79 - 4.2.79

Fig. 5(d)

MELBOURNE-PERTH(LOOPED) SEMATRANS MODEM 72KBIT/S
DISTRIBUTION OF ERROR FREE SECOND RUNS FOR PERIOD 5/ 2/79 - 11/ 2/79



TOTAL NO. OF E.F.S.R. = 21662

Fig. 5(e) Percentage Histogram of Error-Free-Second Runs for Melbourne-Perth 72 kbit/s Data Loop. Period : 5.2.79 - 11.2.79

Fig. 5(e)

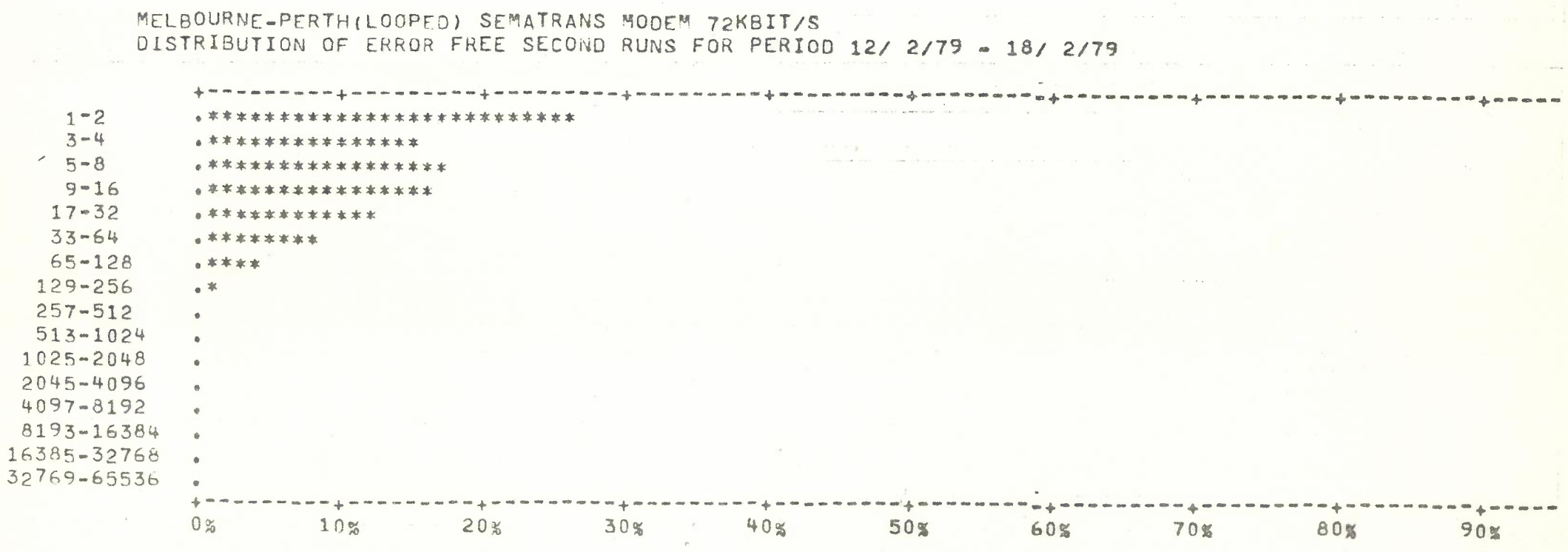


Fig. 5(f) Percentage Histogram of Error-Free-Second Runs for Melbourne-Perth 72 kbit/s Data Loop. Period : 12.2.79 - 18.2.79

Fig. 5(f)

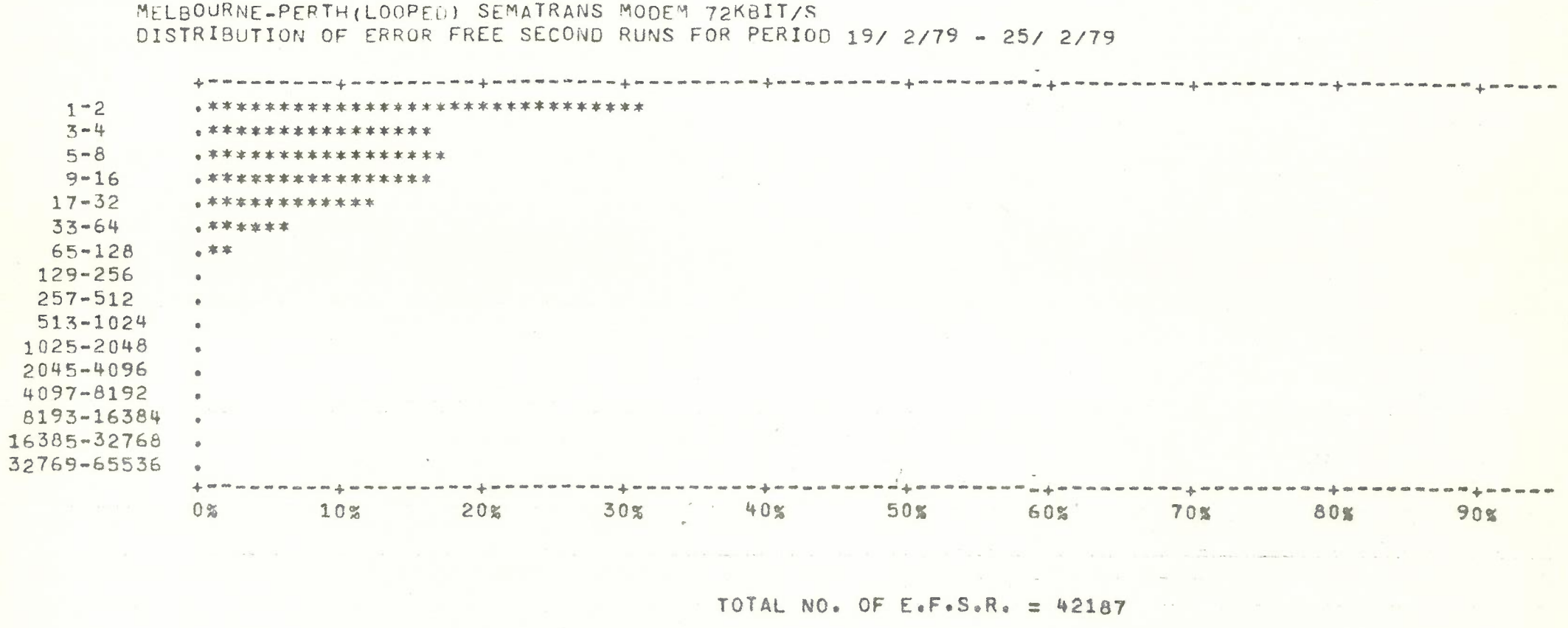


Fig. 5(g) Percentage Histogram of Error-Free-Second Runs for Melbourne-Perth 72 kbit/s Data Loop. Period : 19.2.79 - 25.2.79

Fig. 5(g)

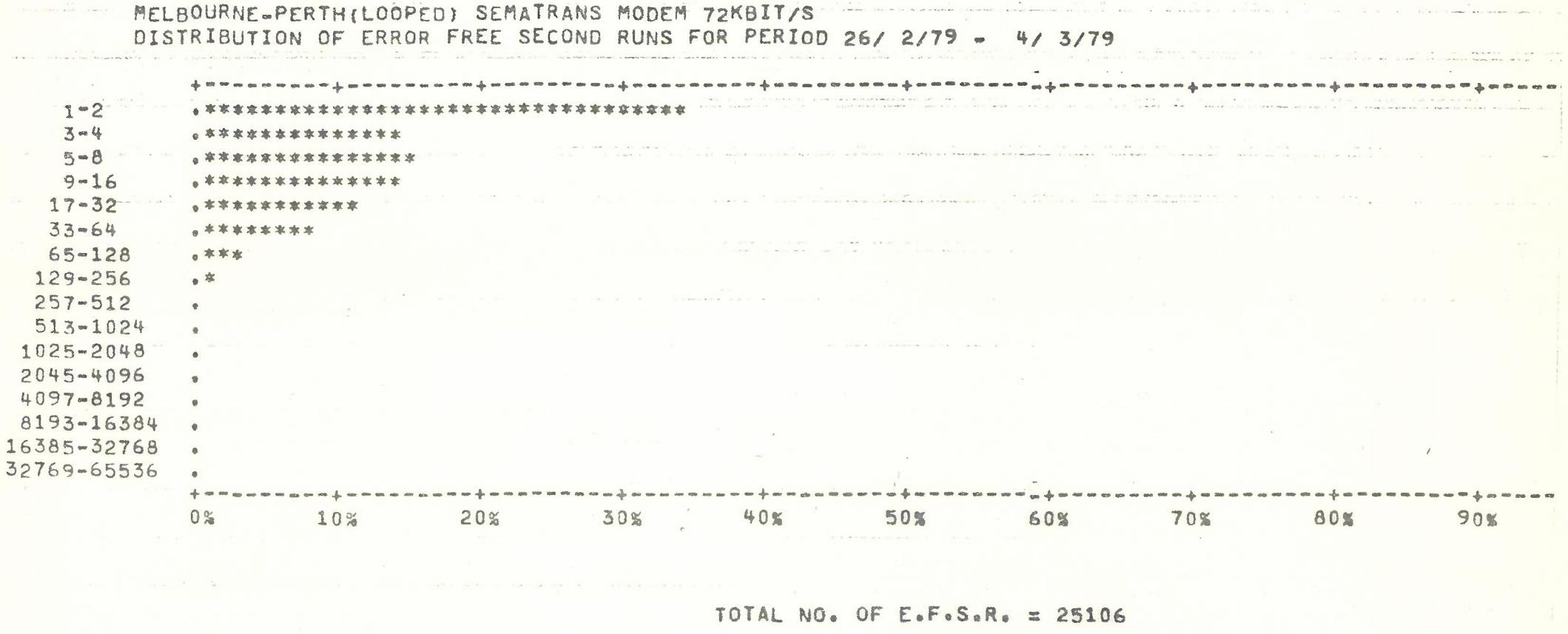


Fig. 5(h) Percentage Histogram of Error-Free-Second Runs for Melbourne-Perth 72 kbit/s Data Loop. Period : 26.2.79 - 4.3.79

Fig. 5(h)