Government of Canada
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PD 8302 E

EVALUATION OF THE RECEPTION QUALITY OF A 5.72 MBITS/SEC TELETEXT SIGNAL ON CABLE TELEVISION SYSTEMS

MAGELLA BOUCHARD

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PLANNING AND DEVELOPMENT SECTION CABLE TV ENGINEERING DIVISION

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1. INTRODUCTION

It will very soon become common practice to transmit a 5.72 Mbits/sec teletext signal in the vertical blanking interval. A number of pilot projects are already operating in Montreal and Toronto. Though at first glance, this does not appear to present any problems, it is still important to ensure that all cable television subscribers will be assured of good reception of the teletext signal. Certain studies carried out in 1982, on the transmission of a 5.72 Mbits/sec teletext signal on cable television systems, were not sufficiently conclusive. It was therefore necessary to carry out further transmission tests on the 5.72 Mbits/sec teletext signal on cable television systems.

The purpose of this study was as follows:

1- To determine the transmission quality of a 5.72 Mbits/sec teletext signal on a cable television system considering the various types of systems encountered.

2- In instances where reception is marginal, to identify the limiting factors causing these reception problems. For example: multiple echos, AML links, the number of cascaded amplifiers, etc.

3- To make recommendations to solve any problems identified.

This report presents the findings from tests carried out on two cable television systems in the Ottawa area, namely Ottawa Cablevision and Skyline Cablevision.

The tests consisted of:

1- Measuring the bit error rate and the line loss rate with the Norpak Mark III decoder;

2- Taking photographs of the various test signals to be used to identify the various problems encountered.

A mobile unit was specially equipped to carry out the necessary tests at distant test points. The study was carried out during the fall of 1982.

2. EQUIPMENT SET-UP PROCEDURES

2.1 Modulation Equipment

The teletext signal was inserted at the headend using a teletext signal generator designed by the Telidon Group at CRC. The teletext sequence formed a line of pseudo-random data at 5.72 Mbits/sec. This sequence was inserted on line 18 of each field of the video signal. The resulting video signal was then modulated using a Rohde & Schwarz modulator, Model SBUF-E1. Figure 2.1 shows the set-up of the teletext signal insertion system. The modulation signal can also be produced by the Wandel & Goltermann group delay delay test system. This instrument was used to generate the signals needed to measure the group delay and frequency response of the channel being tested.

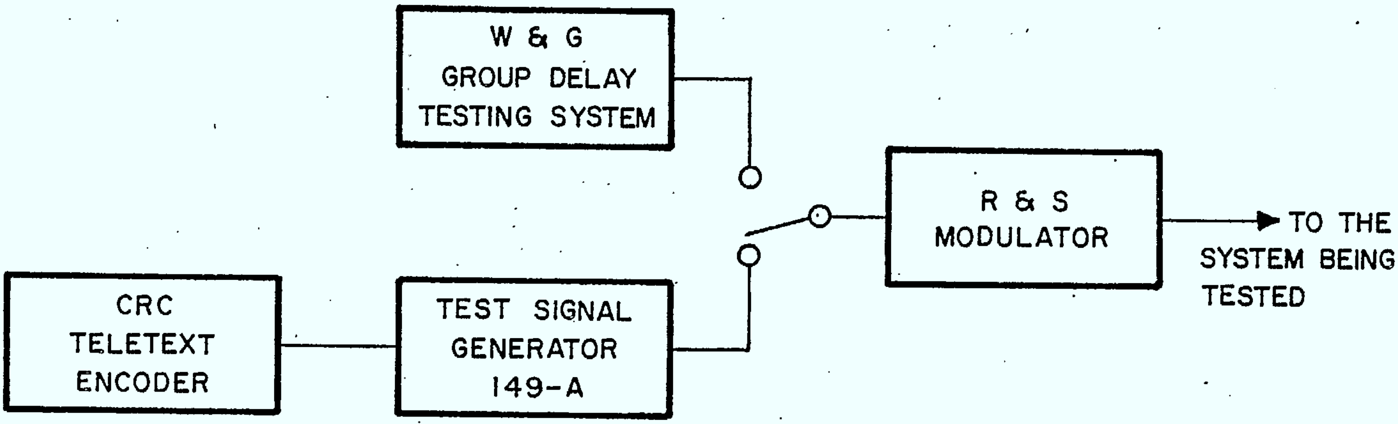
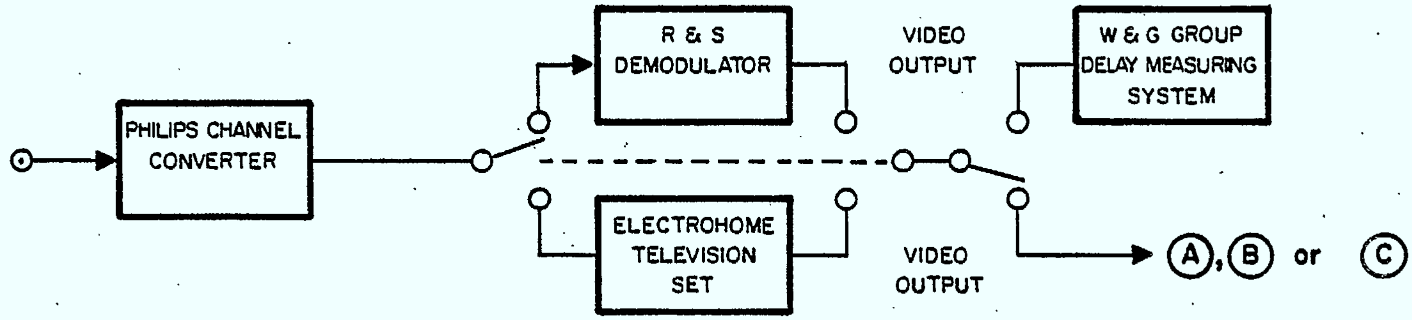


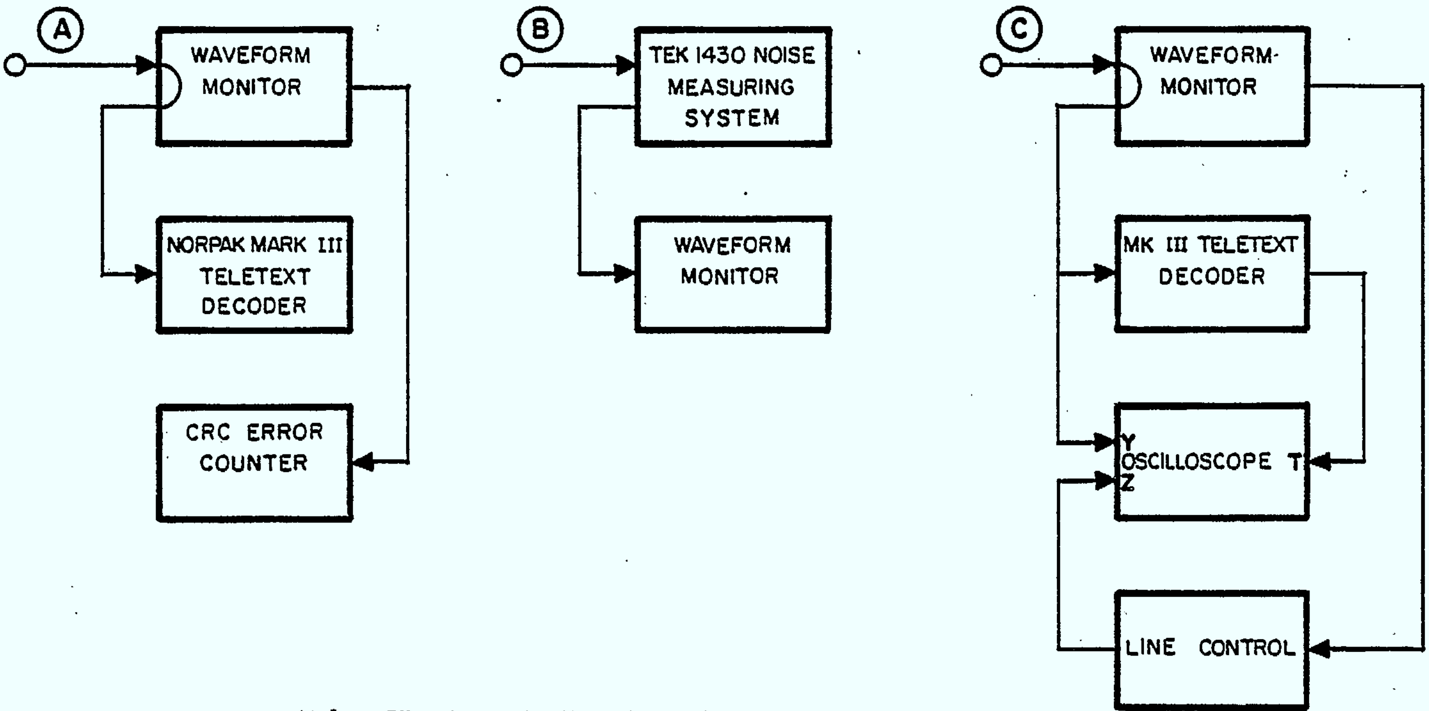
Figure 2.1: Set-up of the teletext signal insertion system and the group delay testing system

2.2 Demodulation and Testing Equipment

Various instruments, set-up in a vehicle, were used to demodulate and measure the characteristics of the teletext signal. The various set-ups used for the testing are shown in Figure 2.2. The channel converter (Figure 2.2a) was used primarily as a band-pass filter. In this way, it was possible to prevent saturation of the input of the R & S demodulator. The RF signal was demodulated by the Rohde & Schwarz demodulator, Model EKF-2 or the Electrohome television set, Model C-46. The Rohde & Schwarz demodulator used either a synchronous detector or an envelope detector, as selected.



(a) DEMODULATION AND FREQUENCY RESPONSE MEASUREMENT (AMPLITUDE AND PHASE)



(b) SET-UPS USED TO MEASURE:

A – BIT ERROR RATES, LINE LOSS RATES

B – SIGNAL-TO-NOISE RATIO

C – EYE DIAGRAM, TEST SIGNAL PHOTOGRAPHS

Fig. 2.2: SET-UP AT THE RECEPTION SITE USED TO EVALUATE THE QUALITY OF THE SIGNAL RECEIVED

2.3 Tests

The reception quality of the 5.72 Mbits/sec teletext signal, as well as the performance of the Norpak Mark III decoder were evaluated using the following tests:

(a) Analog measurements

Photographs of the various signals were used to study the analog characteristics of the transmission channel.

- teletext line
- expanded teletext line (synchronization burst)
- multiburst
- 2T and 12.5T pulses
- expanded 2T pulse
- eye diagram
- frequency response
- group delay

(b) Digital measurements

Specific to the Norpak Mark III decoder

- bit error rate (BER)
- line loss rate (LLR)

2.4 Procedures

2.4.1 Frequency Response and Group Delay

The frequency response and group delay of the channels used were measured using Wandel & Goltermann instruments (see Figures 2.1 and 2.2(a)).

2.4.2 Bit Error Rate and Line Loss Rate

Figure 2.2(b) shows the set-up used to measure the bit error rate and the line loss rate. The bit error counter designed by the CRC Telidon Group displayed the following information:

- number of bits in error
- number of lines decoded
- number of lines transmitted

The following calculations were used to determine the bit error rates and the line loss rates:

$$\text{Bit error rate} = \frac{\text{no of bits in error}}{\text{no of lines decoded x no of bytes/line x 8}}$$

$$\text{Bit error rate} = \frac{\text{no of bits in error}}{\text{248 x no of lines decoded}}$$

$$\text{Line loss rate} = \frac{\text{no of lines transmitted - no of lines decoded}}{\text{no of lines transmitted}}$$

The line loss rate is expressed as a percentage. Measurements made by the bit error counter do not take into account the correction code. The teletext decoder which uses the correction code should give results significantly higher than those given in this report.

2.4.3 Eye Height

The eye height was calculated from the photographs of the eye diagram taken using the set-up shown in Figure 2.2(b) (diagram C). The eye height was calculated as follows:

$$\text{Eye height} = \frac{\text{lowest level of "1" - highest level of "0" x 100}}{\text{"1" constant level - "0" constant level}}$$

The following limiting factors must be taken into consideration in this measurement:

(1) The estimate of the eye height from the photographs is accurate to approximately $\pm$ 5%.

(2) The measurement is taken at the point of maximum aperture. It does not allow for the relative position of the synchronization burst determining the decision instant. In some cases, where there is significant phase distortion, the decoder could place the decision instant in a location that does not correspond to the maximum eye aperture.

2.4.4 Signal-to-Noise Ratio

The signal-to-noise ratio was tested using the set-up shown in Figure 2.2(b) (diagram B). The test was made using a reference level of 700 mv RMS which corresponds to a 0 dB unweighted signal-to-noise ratio in a 4.2 MHz bandwidth.

2.5 Reference Signals

The reference signals were the signals obtained when the modulator output (Figure 2.1) was connected directly to the converter input (Figure 2.2(a)). These signals were therefore received under ideal transmission conditions. Photographs of the reference signals obtained in this way are given in Figures 2.3 and 2.4.

The graphs of the group delay and frequency response given in Figure 2.4 were drawn by computer, from the photographs taken from the screen of the Wandel & Goltermann system, in order to facilitate reading and interpretation.

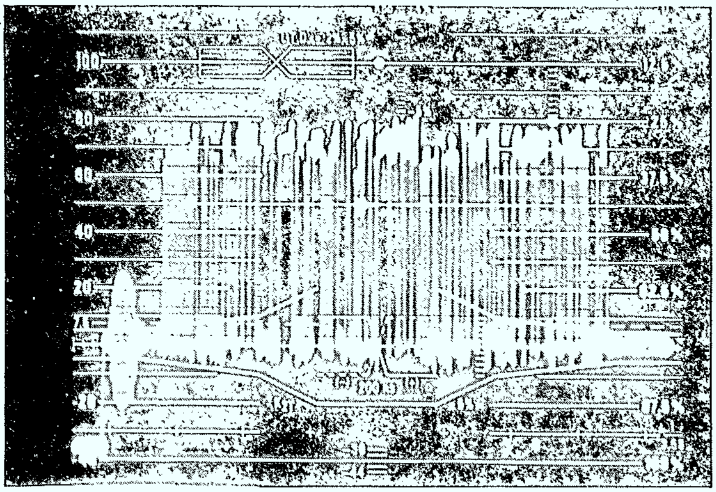
2.6 Teletext Signal Reception Performance Scale

The performance rating for signal reception with the Mark III decoder was determined at each test point using the following scale:

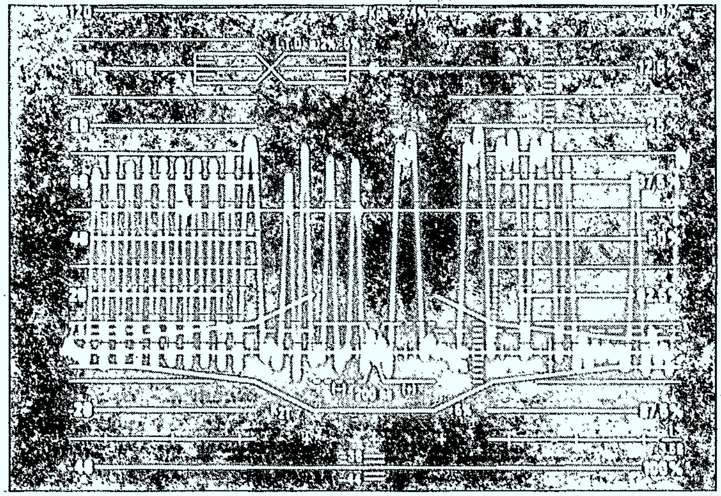
Excellent: $BER < 10^{-4}$
$LLR < 0.1\%$

Good : $10^{-4} \leq BER < 10^{-3}$
$0.1\% \leq LLR < 1\%$

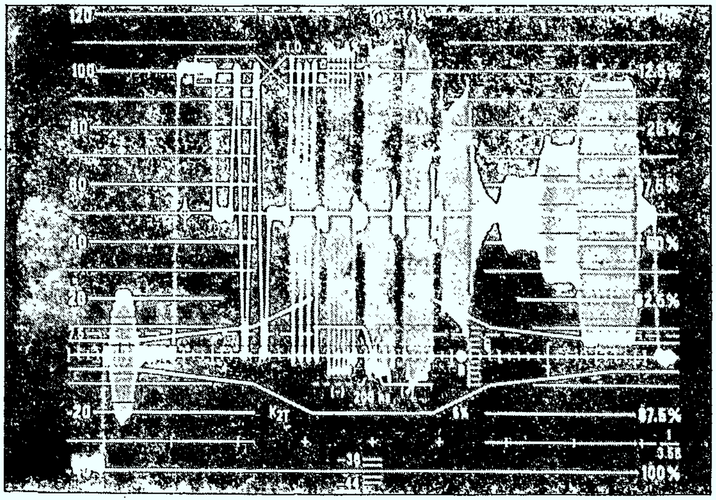
Poor : $10^{-3} \leq BER$
$1\% \leq LLR$



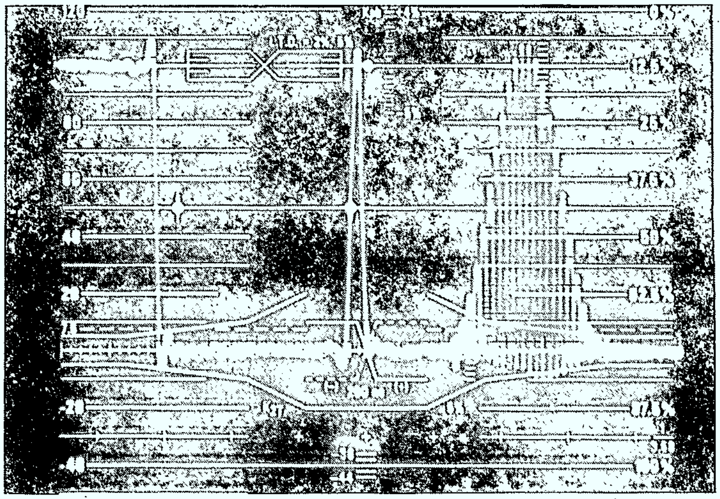
(a) complete teletext line



(b) expanded synchronization and address bytes



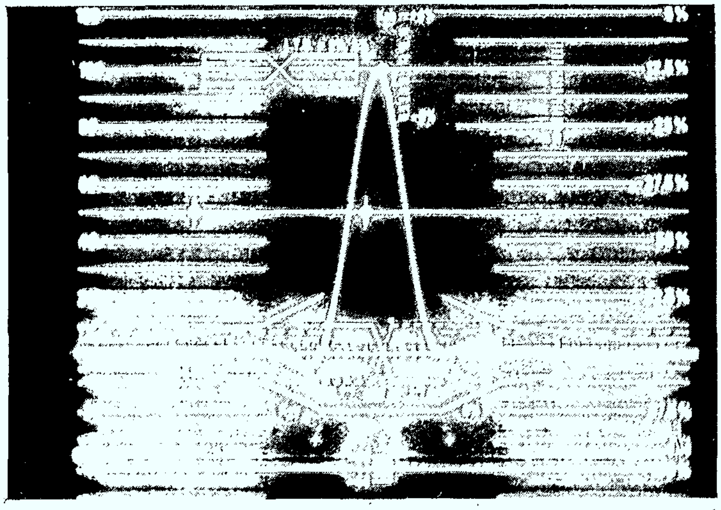
(c) multiburst



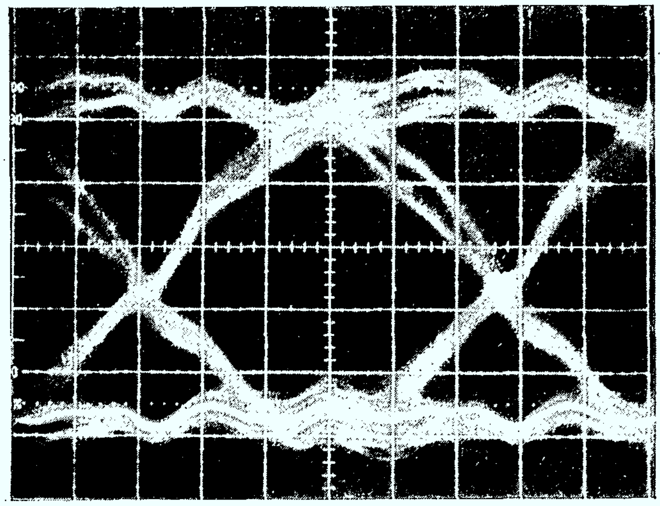
(d) 2T and 12.5T pulses

Figure 2.3: Reference signals

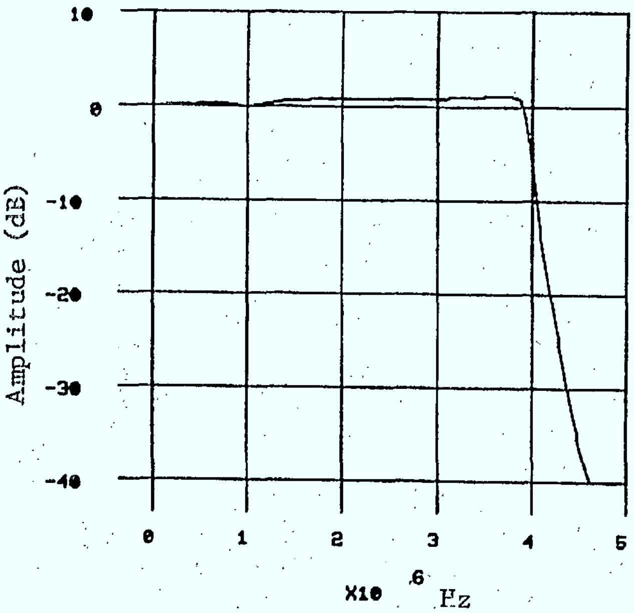
- Photographs showing the results obtained when the R & S modulators, the Philips channel converter and the R & S demodulator in synchronous mode are connected in series. Within the context of these tests, these signals represent the optimum signals.



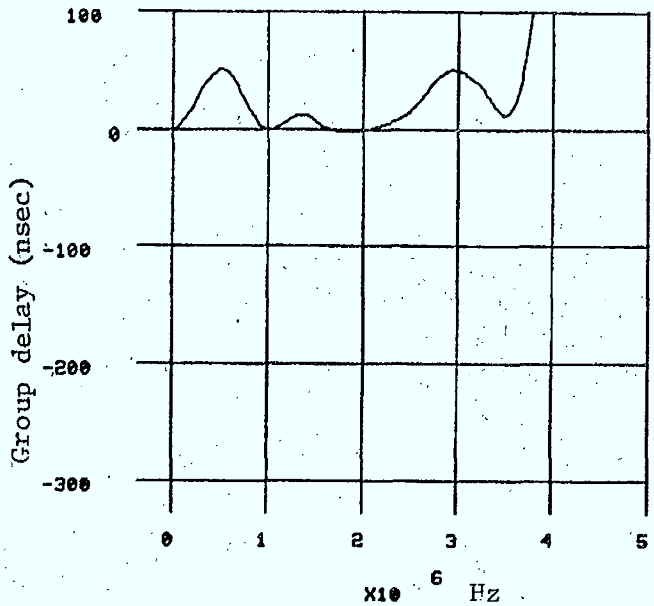
(a) expanded 2T pulse



(b) eye diagram



(c) frequency response



(d) group delay

Figure 2.4: Reference signals (continuation of Figure 2.3)

2.7 List of the Instruments Used

Instrument	Manufacturer	Model
Teletext insertion system	CRC	-
Bit error counter	CRC	-
Teletext decoder	Norpak	Mark III
Modulator	Rohde & Schwarz	SBUF-E1
Demodulator	Rohde & Schwarz	EKF-2
Television set	Electrohome	C-46
Waveform monitor	Tektronix	1480
Signal generator	Wandel & Goltermann	CDS-1 TFPS-42
Receiver	Wandel & Goltermann	LDE-1 SG-1
Oscilloscope	Tektronix	468
Line pulse amplifier	DOC	-
Noise measurement system	Tektronix	1430
Cable converter	Philips	CTC-6R
Test signal generator	Tektronix	149

3 RESULTS

This chapter contains the numerical results which define the quality of the reception of a 5.72 Mbits/sec teletext signal on the two cable television systems tested. The plan of the system and a brief description of the test points used are given prior to presenting the results for each of the systems. The results are given in tabular form and show the bit error rate, the line loss rate and the eye height. The results are given by the type of demodulator used for each of the test points.

For each channel tested, a statistical rating, based on the scale presented in Chapter 2, summarizes the results.

3.1 System No 1

3.1.1 System plan

Figure 3.1 contains the plan of System No 1. The teletext signal was modulated and inserted at the headend. The various channels (not shown in Figure 3.1) were combined in three groups and then transmitted by cable to the AML transmitting site. Each group consists of 8 non-adjacent channels so as to prevent interference between adjacent channels. A trunk with 43 amplifiers also comes from the headend combiner. This trunk is the only one that does not use an AML link.

At the AML transmitting site, the channels are separated by filtering and retransmitted by a low-power AML link. The two AML reception sites tested were 19.2 km and 9.6 km from the transmitting site. The first has a line of 15 amplifiers and the second, 41 amplifiers.

3.1.2 Description of the test points

The various test points are indicated on the system plan in Figure 3.1 by the letters TP (Test Point) followed by the number of the test point.

TP-1: Modulator output (reference point)

TP-2: Output of the AML Monitor receiver

TP-3: End of the 43-amplifier trunk

TP-4: Output from the 1st amplifier after AML receiver No 1

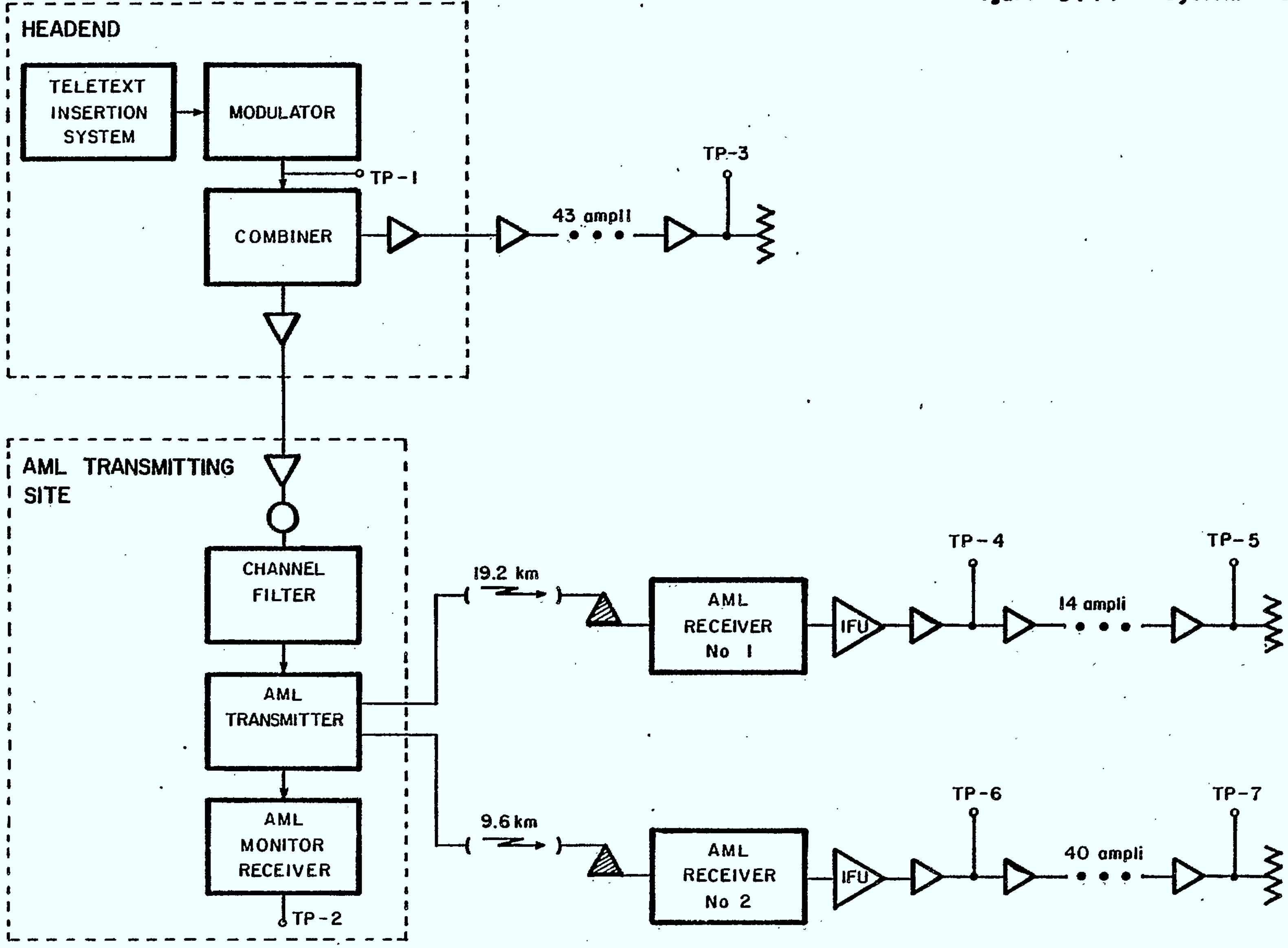
TP-5: Output from the 15th amplifier after AML receiver No 1

TP-6: Output from the 1st amplifier after AML receiver No 2

TP-7: Output from the 41st amplifier after AML receiver No 2

Skyline

Figure 3.1: System No 1



3.1.3 Results (System No 1)

Table 3.1 shows detailed results of the bit error rate (BER), the line loss rate (LLR) and the eye height for the two channels tested, by test point and by demodulator.

Test Point	Channel	R & S Sync Demod			R & S Env Demod		
		BER	LLR	Eye height	BER	LLR	Eye height
TP-3	30	0	0	70 %	10^{-5}	1.0%	57 %
	27	-	-	-	-	-	-
TP-4	30	0	0	82 %	0	0	70 %
	27	0	0	70 %	0	1.0%	58 %
TP-5	30	10^{-5}	0	57 %	10^{-3}	0.1%	50 %
	27	0	0	81 %	0	0.1%	60 %
TP-6	30	0	0	78 %	0	0	74 %
	27	0	0	81 %	0	0	52 %
TP-7	30	0	0	57 %	0	0	50 %
	27	-	-	-	-	-	-

Table 3.1: Results of the reception tests of a 5.72 Mbits/sec teletext signal on System No 1 with the Norpak Mark III decoder

Tables 3.2 and 3.3 show the statistical rating of the quality of reception for Channels 30 and 27 respectively.

Quality of reception	R & S, Sync	R & S, Env
Excellent	100 %	60 %
Good	0 %	0 %
Poor	0 %	40 %

Table 3.2: Statistical rating of the quality of reception of the teletext signal on Channel 30

Quality of reception	R & S, Sync	R & S, Env
Excellent	100 %	33 %
Good	0 %	33 %
Poor	0 %	33 %

Table 3.3: Statistical rating of the quality of reception of the teletext signal on Channel 27

3.2 System No 2

3.2.1 System Plan

Figure 3.2 shows the system plan for System No 2. The signal received at all of the test points, except TP-1 which was the reference at the modular output, has passed through a high-power AML link. The teletext signal was inserted and modulated at the headend and then fed directly to the AML transmitter. The system has four AML reception sites which range from 5.1 km to 15.2 km from the transmitting site. The test points were located at distances between 1 and 34 amplifiers from the AML reception sites.

3.2.2 Description of the test points

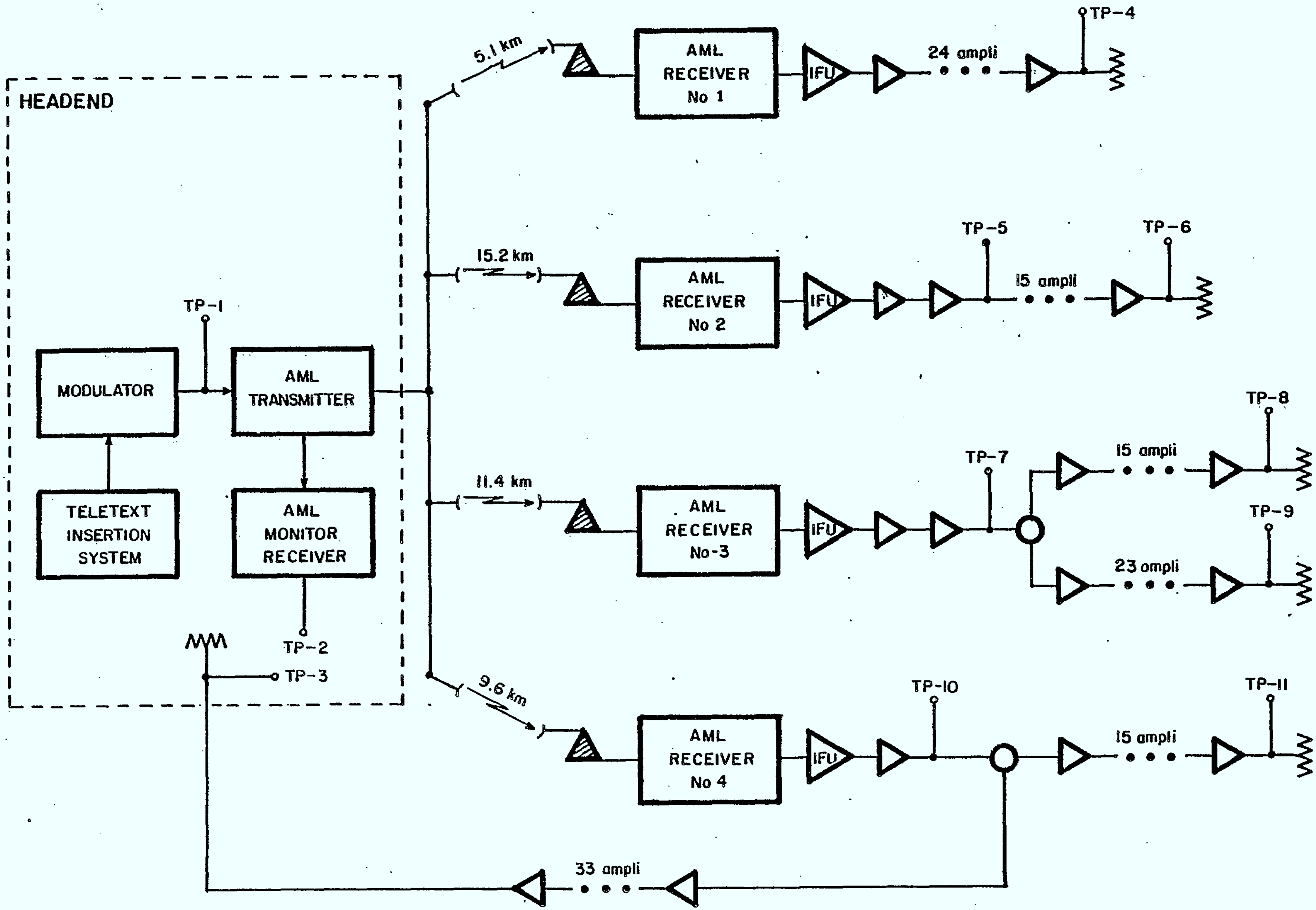
TP-1:	Modulator output (Reference)
TP-2:	AML monitor receiver output
TP-3:	Output from the 34th amplifier after AML receiver No 4
TP-4:	Output from the 24th amplifier after AML receiver No 1
TP-5:	Output from the 2nd amplifier after AML receiver No 2
TP-6:	Output from the 17th amplifier after AML receiver No 2
TP-7:	Output from the 2nd amplifier after AML receiver No 3
TP-8:	Output from the 17th amplifier after AML receiver No 3
TP-9:	Output from the 25th amplifier after AML receiver No 3
TP-10:	Output from the 1st amplifier after AML receiver No 4
TP-11:	Output from the 16th amplifier after AML receiver No 4

3.2.3 Results (System No 2)

Table 3.4 presents detailed results of the bit error rate, the line loss rate and the eye height at all test points used.

Ottawa

Figure 3.2 System No 2



Test Point	Channel	R & S demod in sync mode			R & S demod in env mode			Electrohome Television		
		BER	LLR	Eye height	BER	LLR	Eye height	BER	LLR	Eye height
TP-2	15	0	0	78 %	0	0	70 %	0	0	66 %
	16	0	0	75 %	0	0.1%	-	-	-	-
TP-3	15	0	0	83 %	0	0	67 %	0	0	-
	16	0	0	79 %	0	0	65 %	0	0	60 %
TP-4	15	0	0.1%	79 %	10^{-3}	1.0%	65 %	0	0	45 %
	16	0	0.1%	81 %	0	1.0%	65 %	0	0	42 %
TP-5	15	0	0.1%	77 %	0	1.0%	67 %	0	0	-
	16	0	0	79 %	0	20%	63 %	0	0	56 %
TP-6	15	-	-	-	-	-	-	-	-	-
	16	0	0	79 %	0	0	65 %	0	0	56 %
TP-7	15	0	0	85 %	0	1.0%	73 %	0	0	67 %
	16	0	0	72 %	0	0	57 %	0	0	57 %
TP-8	15	0	0	77 %	0	0	65 %	0	0	68 %
	16	0	0	76 %	0	0	64 %	0	0	54 %
TP-9	15	0	0	85 %	0	0	67 %	0	0	40 %
	16	0	0	73 %	0	0	64 %	0	0	43 %
TP-10	15	0	0	81 %	0	0	64 %	0	0	64 %
	16	0	0	74 %	0	0	66 %	0	0	44 %
TP-11	15	-	-	-	-	-	-	-	-	-
	16	0	0	75 %	0	0	67 %	0	0	57 %

Table 3.4: Detailed results of the reception of the 5.72 Mbits/sec teletext signal on System No 2 with the Norpak Mark III decoder

Tables 3.5 and 3.6 give the statistical rating of the quality of reception of a 5.72 Mbits/sec teletext signal on Channels 15 and 16 respectively.

Quality of reception	R & S, Sync	R & S, Env	Electrohome TV
Excellent	88 %	63 %	100 %
Good	12 %	0 %	0 %
Poor	0 %	37 %	0 %

Table 3.5: Statistical rating of the quality of reception of a 5.72 Mbits/sec teletext signal on Channel 15

Quality of Reception	R & S, Sync	R & S, Env	Electrohome TV
Excellent	90 %	80 %	100 %
Good	10 %	10 %	0 %
Poor	0 %	10 %	0 %

Table 3.6: Statistical rating of the quality of reception of a 5.72 Mbits/sec teletext signal on Channel 16

4 DISCUSSION

This chapter discusses the results obtained on System No 1 and System No 2 separately. The test points where reception of the teletext signal was not excellent will be examined. Examination of the photographs taken at certain points makes it possible to identify and explain special problems with reception of the teletext signal.

4.1 System No 1

Tests of System No 1 were made on two channels (Channels 30 and 27) with two types of demodulators (R & S sync and R & S env). The synchronous demodulator produced excellent results on both channels at all test points. The results with the envelope demodulator were significantly poorer. Several test points recorded poor reception with this type of demodulator. We will examine the exact causes of these problems later in the chapter.

- **Microwave link (AML)**

System No 1 has two low-power AML links. For a given channel, the quality of the signal remains virtually the same from one reception site to another. However, the transparency of a low-power AML link can vary slightly from one channel to another. Both of the channels selected for these tests produced excellent results. Figures 4.1 and 4.2 show photographs of the test signals at the output of an AML link on Channel 30 and Channel 27 respectively. Figure 4.2 corresponds to Channel 30 at the output of AML receiver No 1 (TP-4). Figure 4.2 corresponds to Channel 27 at the output of the same AML receiver No 2 (TP-4). There is very little impairment of the test signals with respect to the reference signals (see the reference signals in Figures 2.3 and 2.4). However, the eye height on Channel 30 is 82%, while it is only 70% on Channel 27. This difference could be caused by the tuning of the AML transmitters or by echo problems on the line between TP-4 and TP-5.

In general, low-power AML links can be regarded as being relatively transparent. However, this transparency is obtained only with proper adjustment and maintenance of the AML transmitter. A separate study has been undertaken concerning the special problems associated with AML systems and a report will be forthcoming shortly.

- **Echo problems**

On system No 1, echos contributed the most to the deterioration of the teletext signal. Multiple echos, apparently caused by damaged underground cables, were recorded on two of the three lines tested. The signal received at TP-5 on Channel 20 (Figure 4.3) had a major echo signal that was above the permissible level set forth in BP-23 (echo rating > 7%).

Undershoots of the teletext signal were recorded at -30 IRE. These undershoots can affect the synchronization of the Mark III decoder, thereby causing line losses. Echos also decrease the eye height. The eye height was only 57% for the synchronous demodulator and 50% for the envelope demodulator.

In spite of the existence of equally large echos, reception of the teletext signal by the Mark III decoder proved excellent with the R & S synchronous demodulator. With the R & S envelope demodulator, the Mark III experienced a line loss rate of close to 1%.

The signals received at TP-7 on Channel 30 were also affected by echos. However, the echos were smaller than those recorded at TP-5. Figure 4.4 (TP-7, Channel 30) shows that the level of the echos remained within the permissible limits set by BP-23 (see the photograph of the expanded 2T pulse). The eye height was 57% for the synchronous demodulator and 50% for the envelope demodulator, the same as at TP-5. The overshoots, on the other hand, were much smaller and the eye diagram was much sharper in the photograph. The Mark III decoder performed excellently at TP-7 with both types of demodulators.

- **43-amplifier trunk**

The only test point not using an AML link is TP-3. The trunk has 43 amplifiers connected in cascade which represents approximately the maximum number of cascaded amplifiers that will be found in any cable television system. Figure 4.5 shows the test signals obtained at TP-3 on Channel 30. There is only slight distortion of these signals and the signal-to-noise ratio is 31 dB. The Mark III decoder recorded excellent performance with the synchronous demodulator. However, with the envelope demodulator, the noise level and echo (as can be seen on the 2T pulse) were sufficient to cause poorer reception of the teletext signal (BER = 10^{-5}, LLR = 1%).

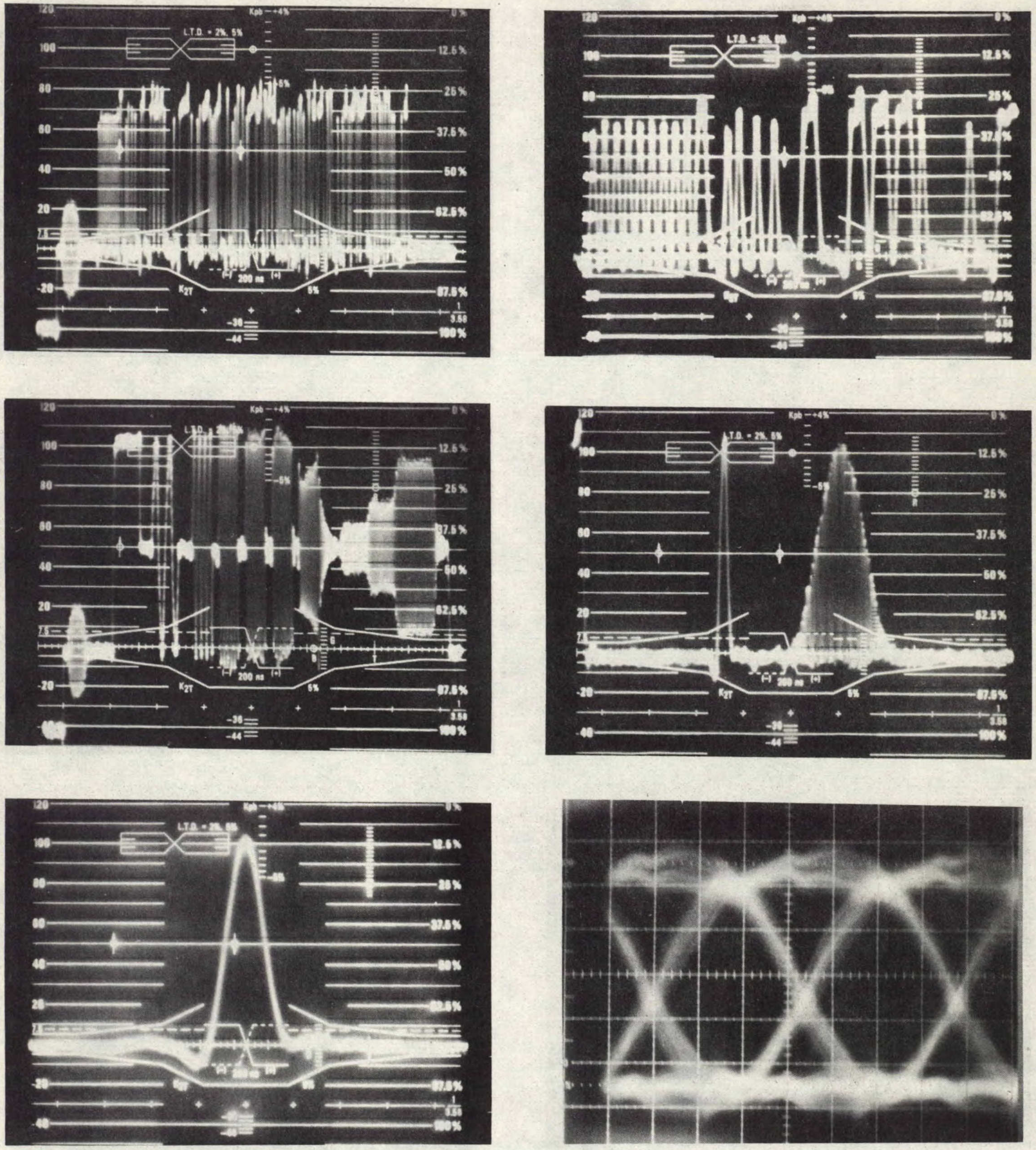


Figure 4.1: System No 1, TP-4, Channel 30

- Photographs showing the quality of the signal received on Channel 30 at an AML reception site. (10 km link) R & S demodulator in synchronous mode.

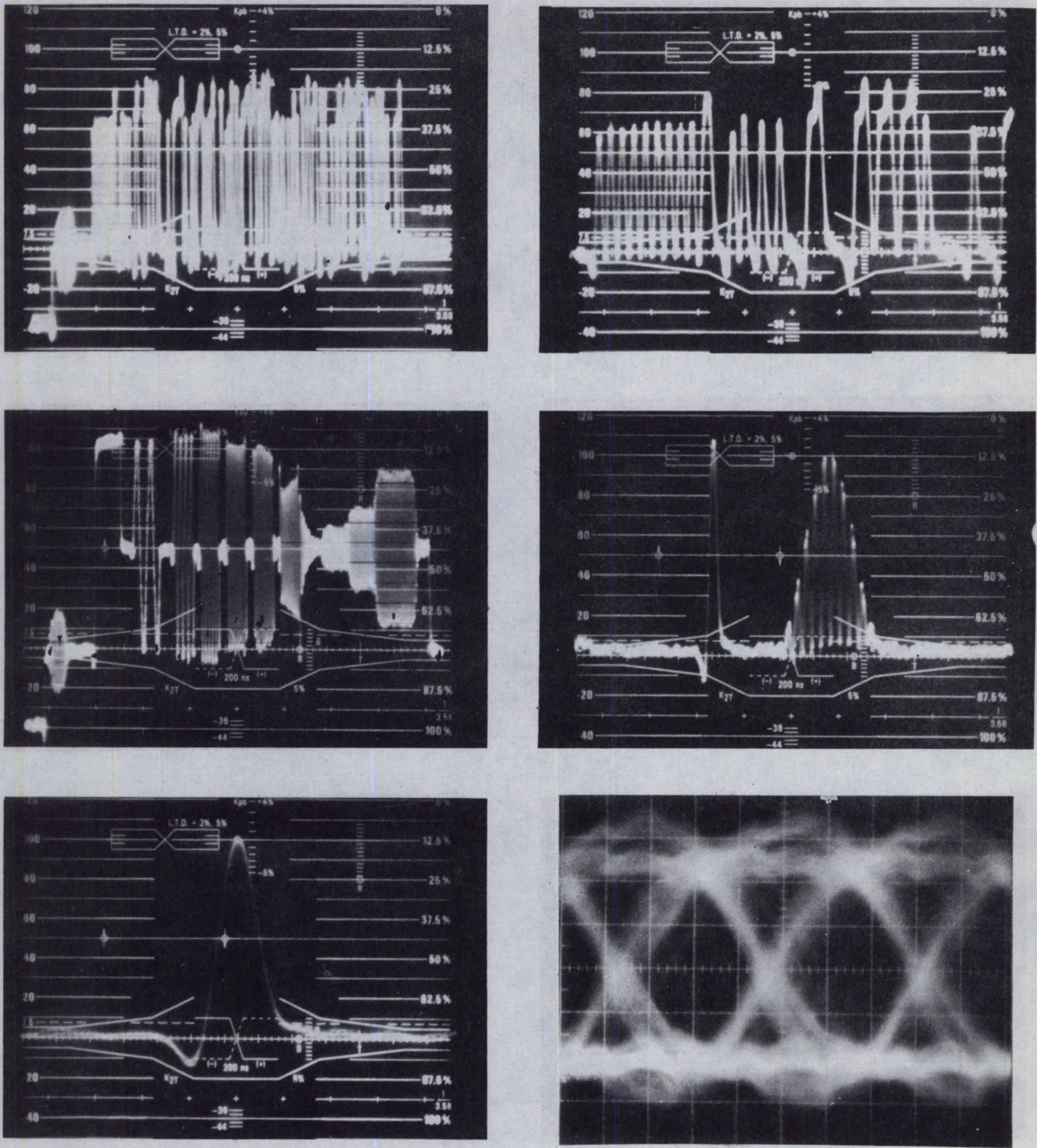


Figure 4.2: System No 1, TP-4 Channel 27

- Photographs showing the quality of the signal received on Channel 27 at an AML reception site. (20 km link) R & S demodulator in synchronous mode.

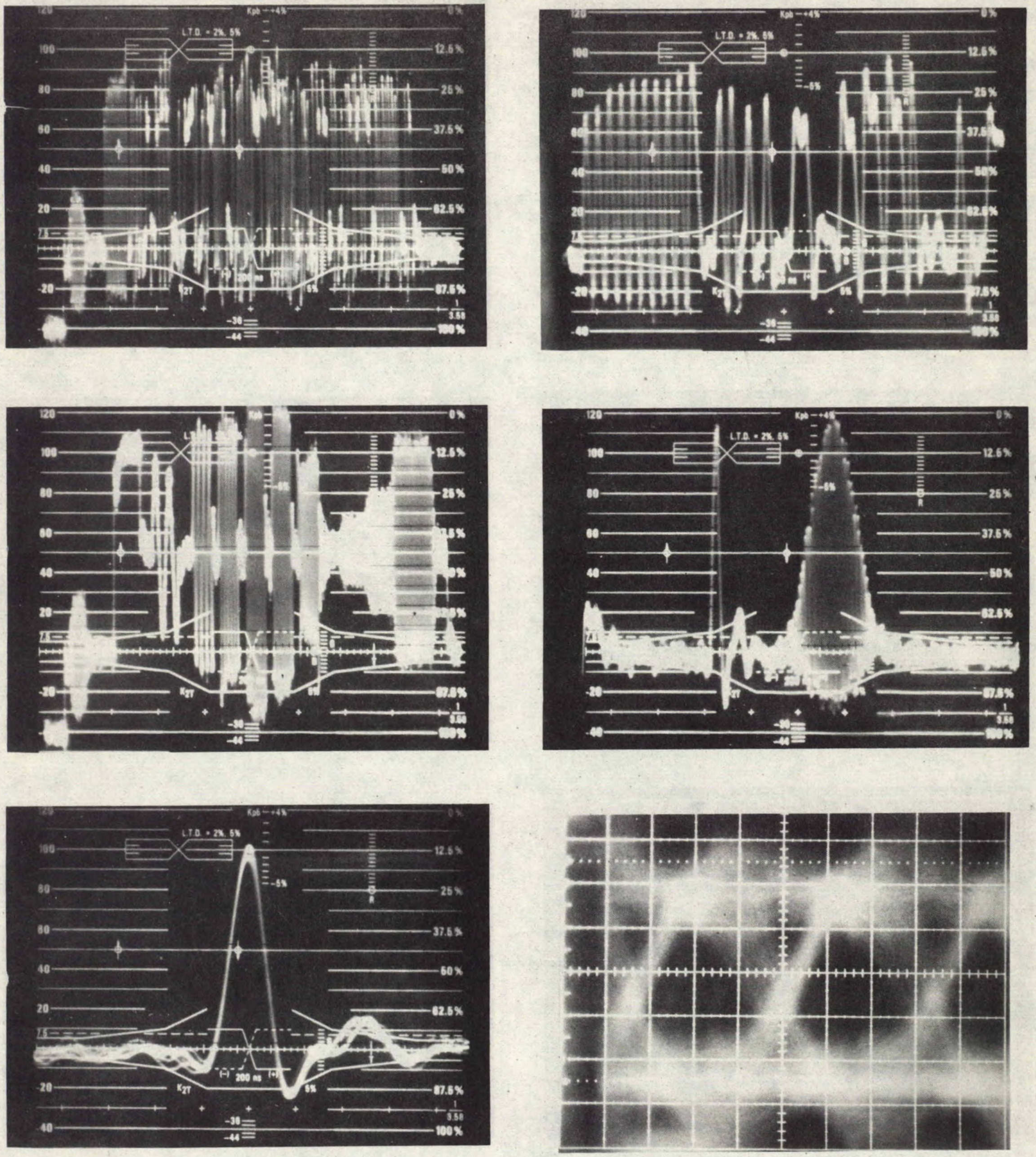


Figure 4.3: System No 1, TP-5, Channel 30

- Photographs showing the quality of the signal received. Note the major echo. R & S demodulator in synchronous mode.

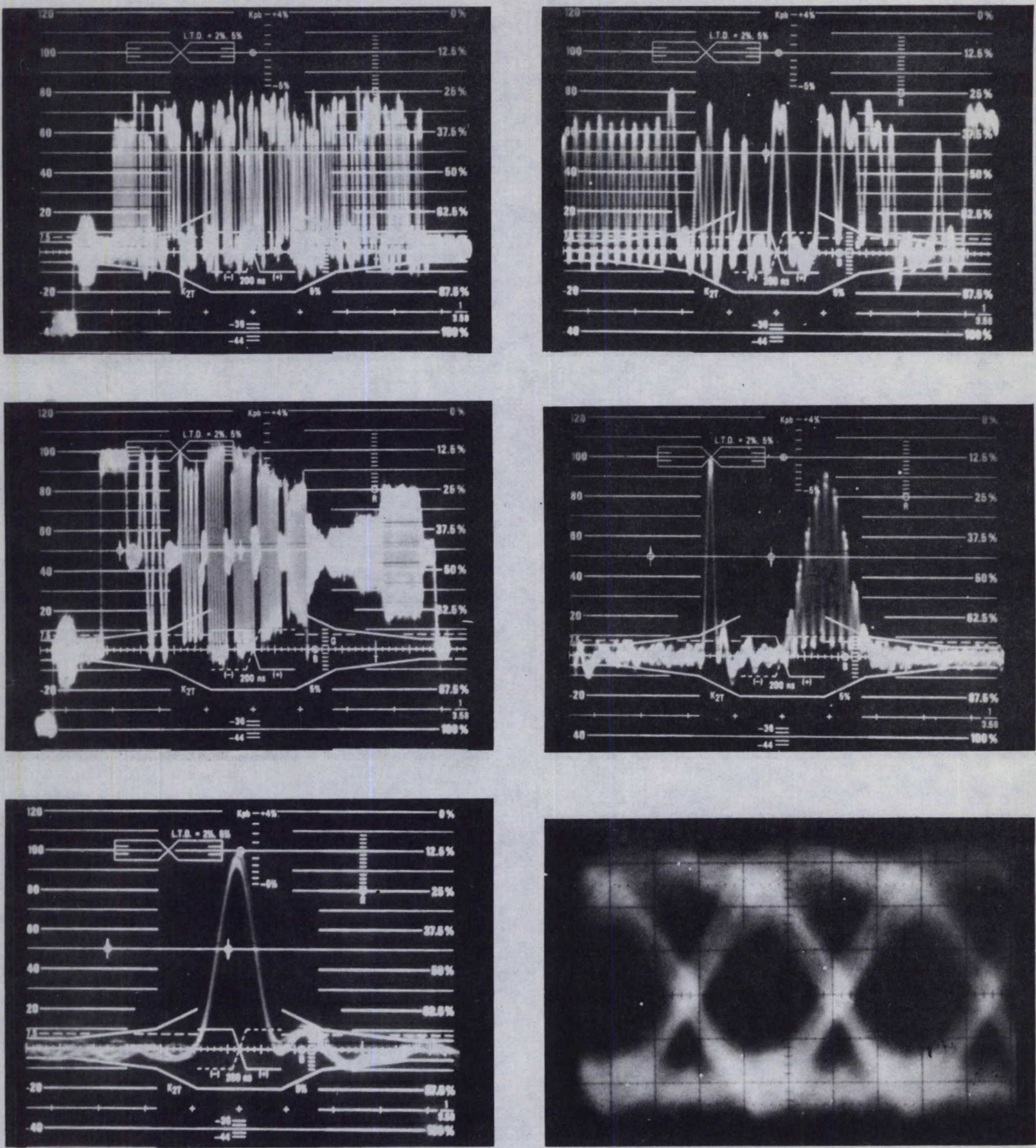


Figure 4.4: System No 1, TP-7, Channel 30

- Photographs showing the quality of the signal received. Note the presence of an acceptable echo (BP-23). R & S demodulator in synchronous mode.

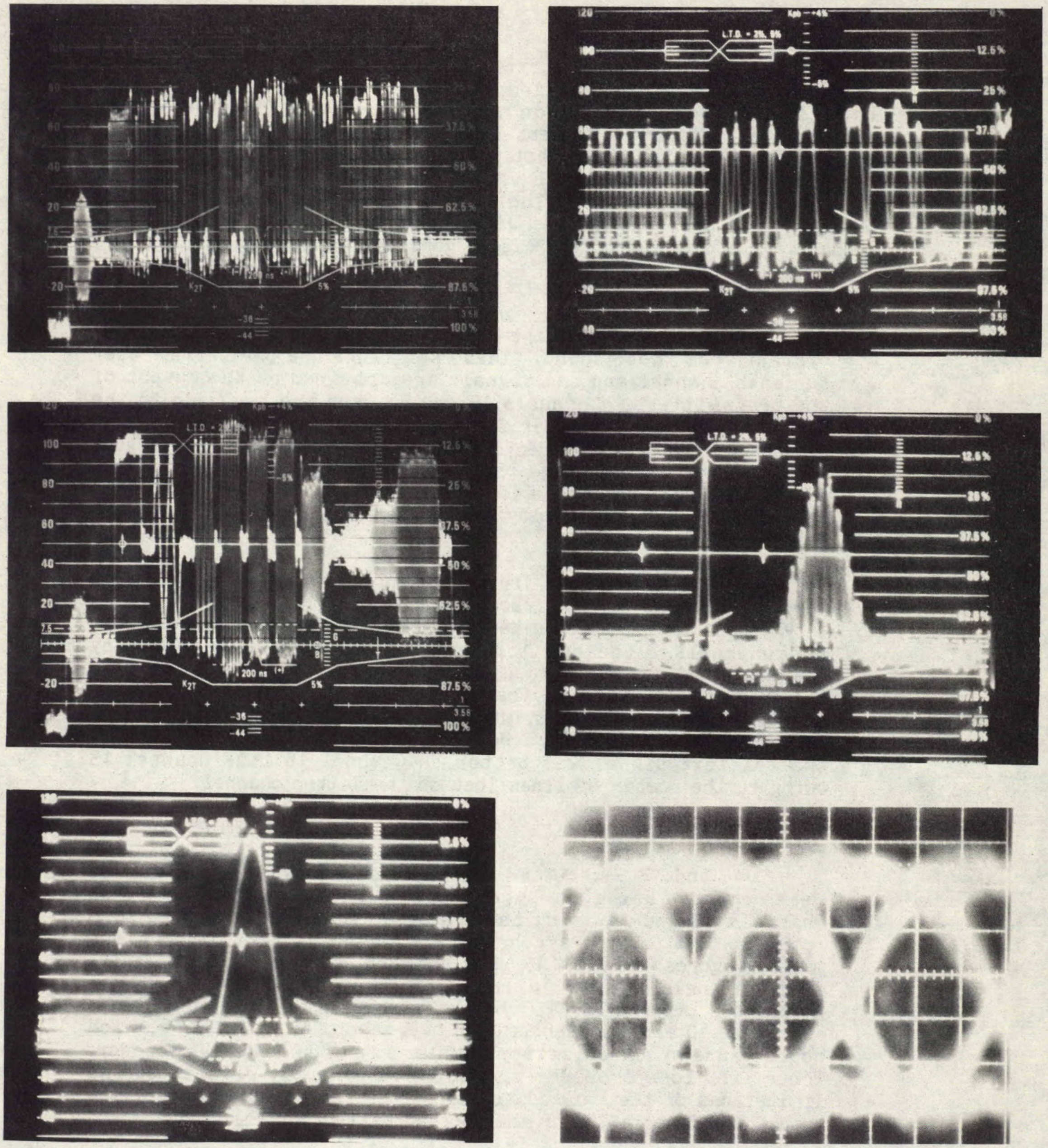


Figure 4.5: System No 1, TP-3, Channel 30

- Photographs showing the different test signals received at the end of a 43-amplifier trunk. R & S demodulator in synchronous mode.

4.2 System No 2

The quality of the teletext signal at most of the test points used in System No 2 was excellent. Of the three demodulators tested, the Electrohome Television set provided the best decoding performance, offering excellent reception of the teletext signal on both channels tested a all test points. With the R & S demodulator in synchronous mode, reception was excellent in 84% of the cases and good in the remaining 16%. The R & S demodulator in envelope mode provided the worst performance with reception of the teletext signal being excellent in 72% of the cases, good in 6% and poor in 22%.

- AML Link

System No 2 uses high-power AML links to reach regions distant from the headend. These AML links use one transmitter for each channel and the signals are combined at the output of the transmitters. Channels 15 and 16 were the two used in the study. The AML transmitter for Channel 15 had an abnormally high frequency response at video frequencies above 2 MHz (see Figure 4.6). Figure 4.7 shows the photographs of the test signals taken at AML reception site No 4 (TP-10) on Channel 16. The signals on that channel did not display the same irregularities as those on Channel 15.

Figure 4.8 shows the frequency responses and group delays on the two channels for AML receiver No 4 (TP-10). It is therefore easy to see the difference between the frequency responses of the two channels. Channel 16, in spite of a better frequency response, had a poorer group delay response (-100 nsec at 2 MHz). The frequency response of Channel 15 improved the eye height and increased the overshoots, while the group delay for Channel 16 decreased the eye height. However, statistically, reception of the teletext signal was better on Channel 16 than Channel 15 owing to the number of lines lost on the latter channel.

- TP-4 and TP-5

TP-4 and TP-5 were the only test points where line losses were recorded using the synchronous demodulator. At TP-4, on Channels 15 and 16 using the R & S demodulator, the line loss rate was 0.1% for the synchronous mode and 1% for the envelope mode. Figures 4.9 and 4.10 show the test signals received at TP-4 on Channels 15 and 16 respectively. The same line loss phenomenon occured at TP-5 but only on Channel 16 (Figure 4.11). Figures 4.10 and 4.11 show major overshoots on Channel 16 which could cause synchronization problems for the Mark III decoder. These line loss problems appear to be directly related to the limitations of the Mark III decoder itself, either because of its principle of operation or the poor adjustment of the unit used.

4.3 Demodulators

Figure 4.12 gives an example of the eye heights obtained with the different types of demodulators. There are major differences in the aperture and symmetry of the eye.

- **R & S synchronous demodulator**

  The quality of reception of the teletext signal with this demodulator was as follows:

excellent	89%
good	11%
poor	0%

  The eye diagram obtained with this demodulator is by far the most open and most symmetrical of the three (see Figure 4.12a).

- **R & S envelope demodulator**

  The envelope detector (demodulator) provided the poorest performance. This detection mode causes distortions because of the quadrature component of the VSB signal. These distortions significantly alter the symmetry of the eye. The dissymetry of the eye diagram obtained with the envelope detector is apparent in Figure 4.12b. In addition, envelope detectors are more sensitive to echo signals than synchronous demodulators.

excellent	65%
good	12%
poor	23%

- **Electrohome television set (quasi-synchronous)**

  The Electrohome television set that was specially modified for teletext uses a quasi-synchronous demodulator. The quality of reception of the teletext signal obtained with this set was excellent:

excellent	100%
good	0%
poor	0%

These results were better than those obtained with the synchronous R & S demodulator. Undershoots causing synchronization problems with the Mark III were significantly reduced with the Electrohome television set. Figure 4.13 shows that the signals demodulated by the Electrohome television had greatly reduced frequency content in the high frequencies. The "Multiburst" signal shows that the cut-off frequency is at about 3 MHz.

Thus, in cases where reception difficulties were caused by overshoots (as is the case for Channel 15) and by a poor signal-to-noise ratio, the Electrohome demodulator gave better results than a demodulator with a larger bandwidth.

However, the eye diagrams obtained with the Electrohome television are less open than those from the R & S synchronous demodulator. The performance of the Electrohome demodulator would therefore have been poorer than that of the R & S synchronous demodulator in cases where the eye height was decreased by echo problems or group delay problems, for example. With the television set, the minimum eye height required for proper operation of the Mark III decoder (30% for a bit error rate of 10^{-4} and a signal-to-noise ratio of 23 dB) would be reached faster.

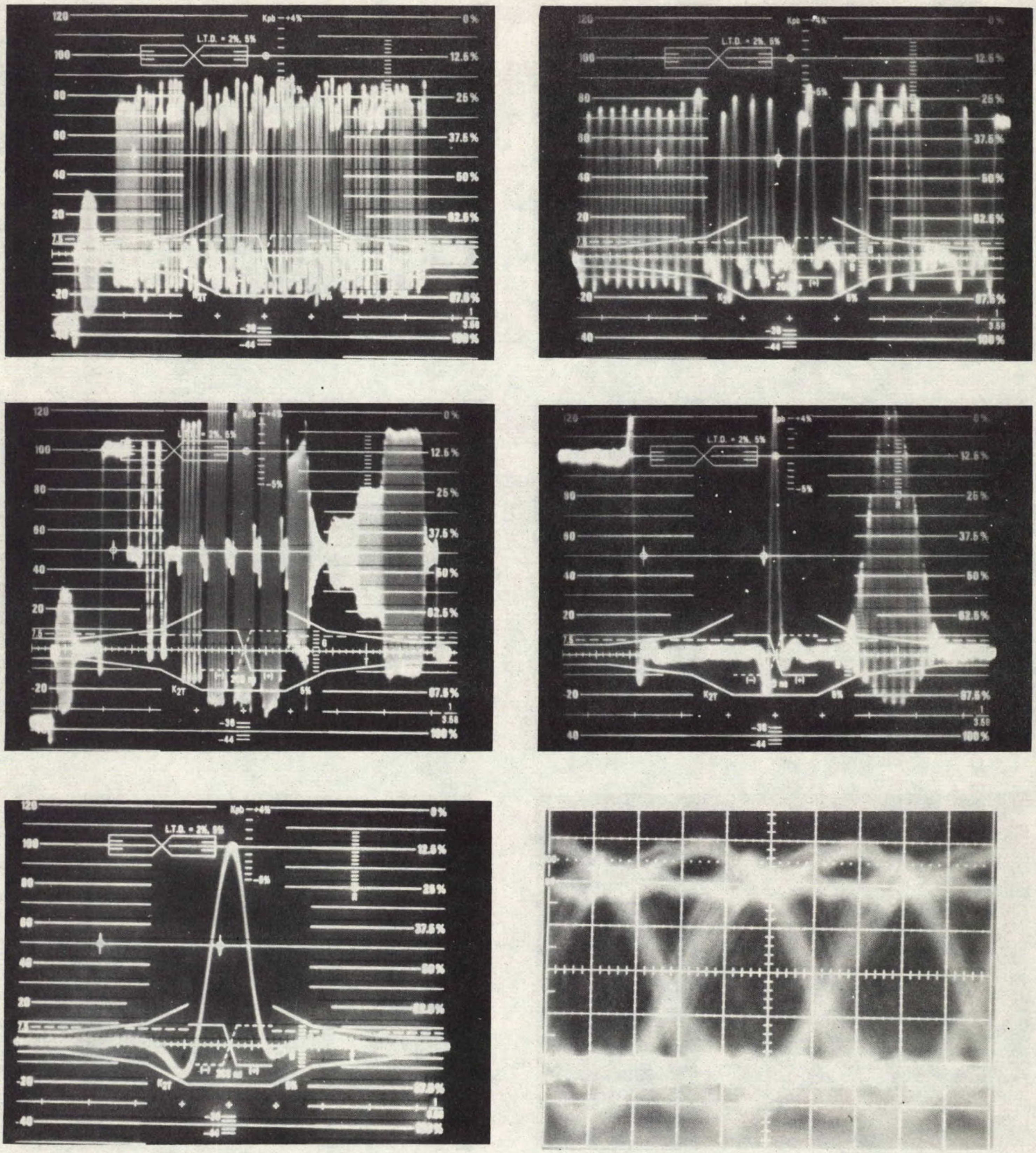


Figure 4.6: System No 2, TP-10, Channel 15

- Photographs showing the quality of the signal received on Channel 15 at an AML reception site (9.6 kM link). The "Multiburst" shows the gain problem at high frequencies due to the AML transmitter. R & S synchronous demodulator.

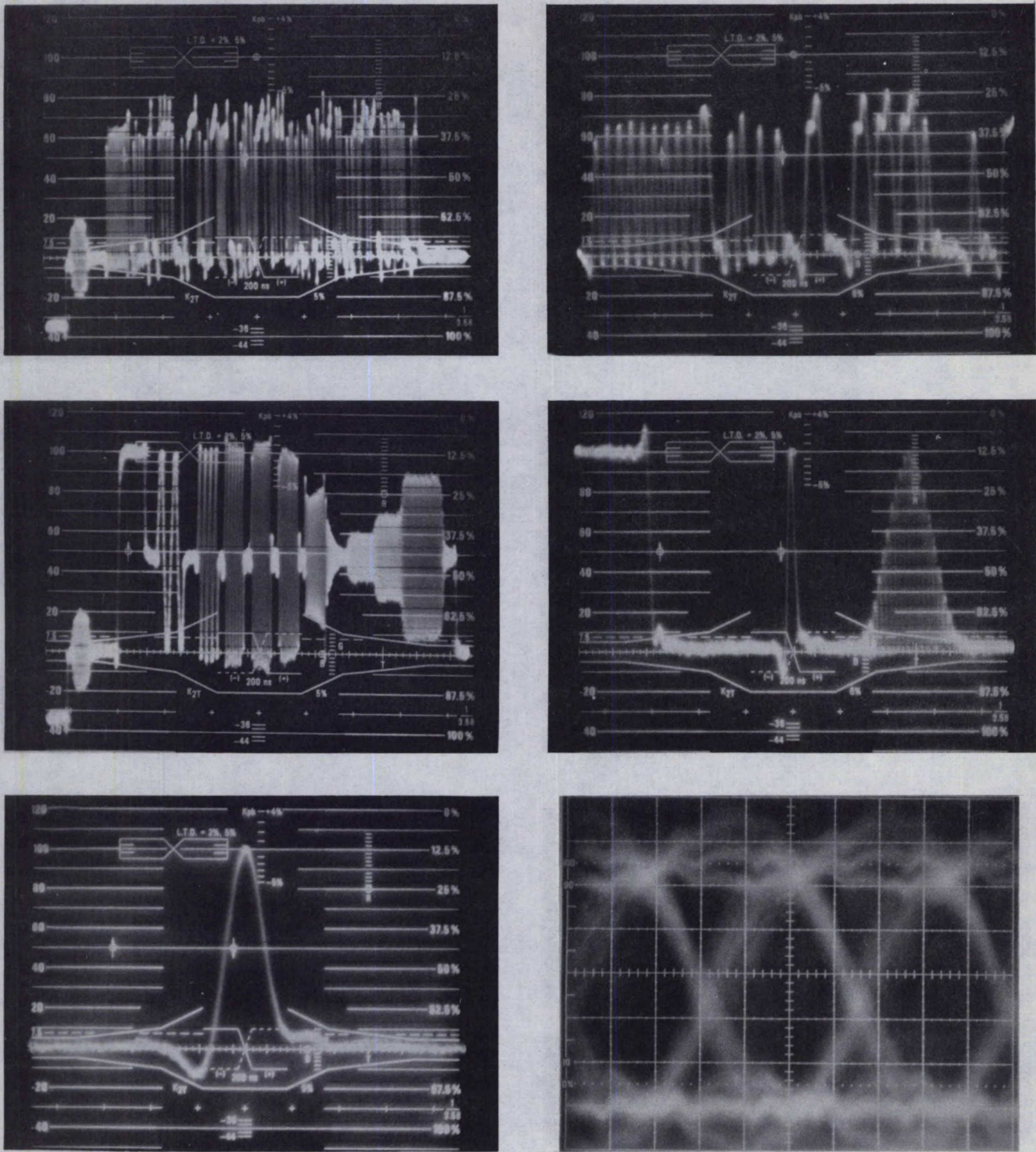
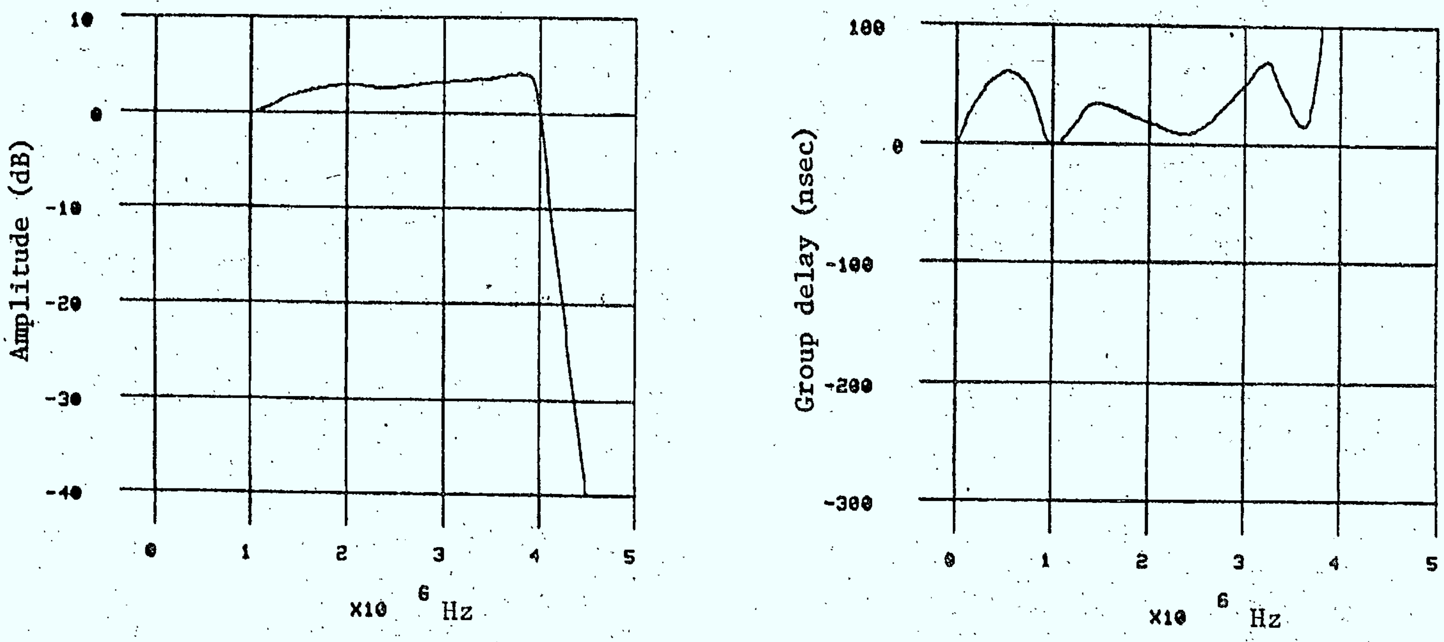
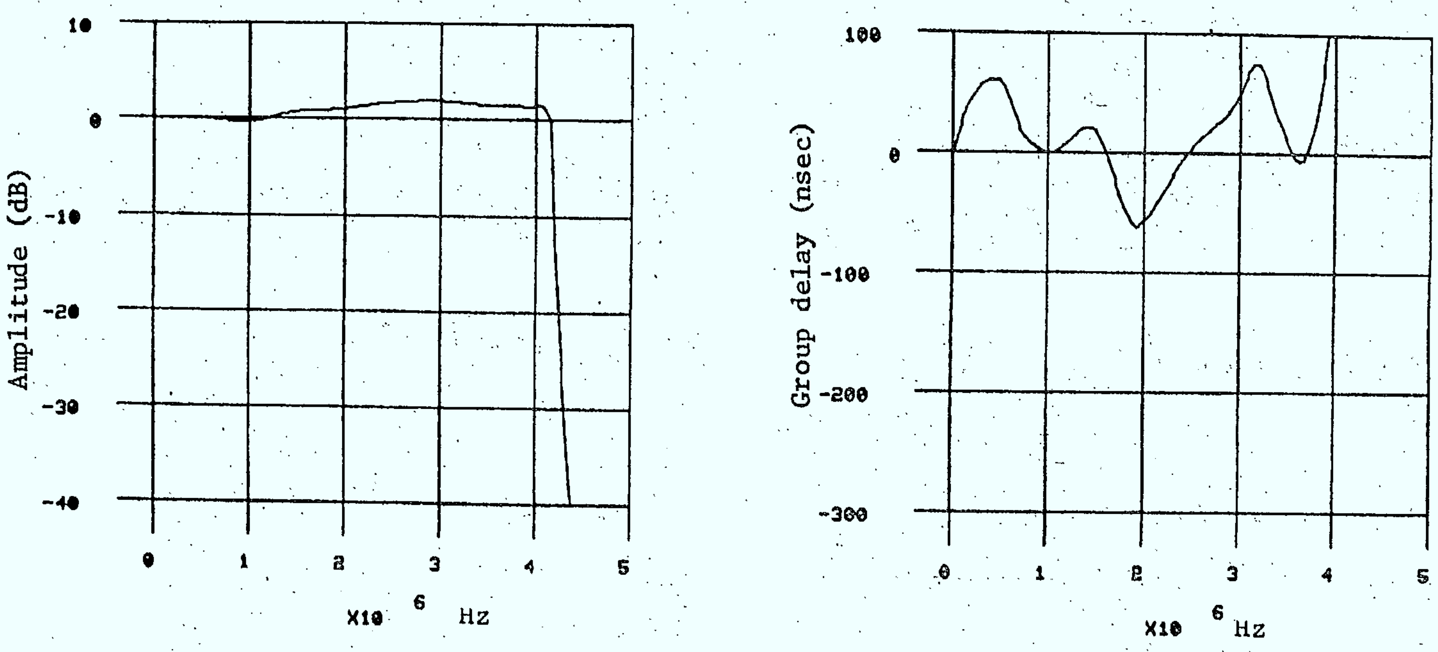


Figure 4.7: System No 2, TP-10, Channel 16

- Photographs showing the quality of the signal received on Channel 16 at an AML reception site (9.6 km link). Unlike Channel 15, (see Figure 4.5), the frequency response of the AML transmitter on Channel 16 does not show any irregularities. R & S synchronous demodulator.



(a) Channel 15



(b) Channel 16

Figure 4.8: System No 2, TP-10, Channel 15 and Channel 16
- Frequency response and group delay measured at AML reception site No 4 (9.6 km link). R & S synchronous demodulator.

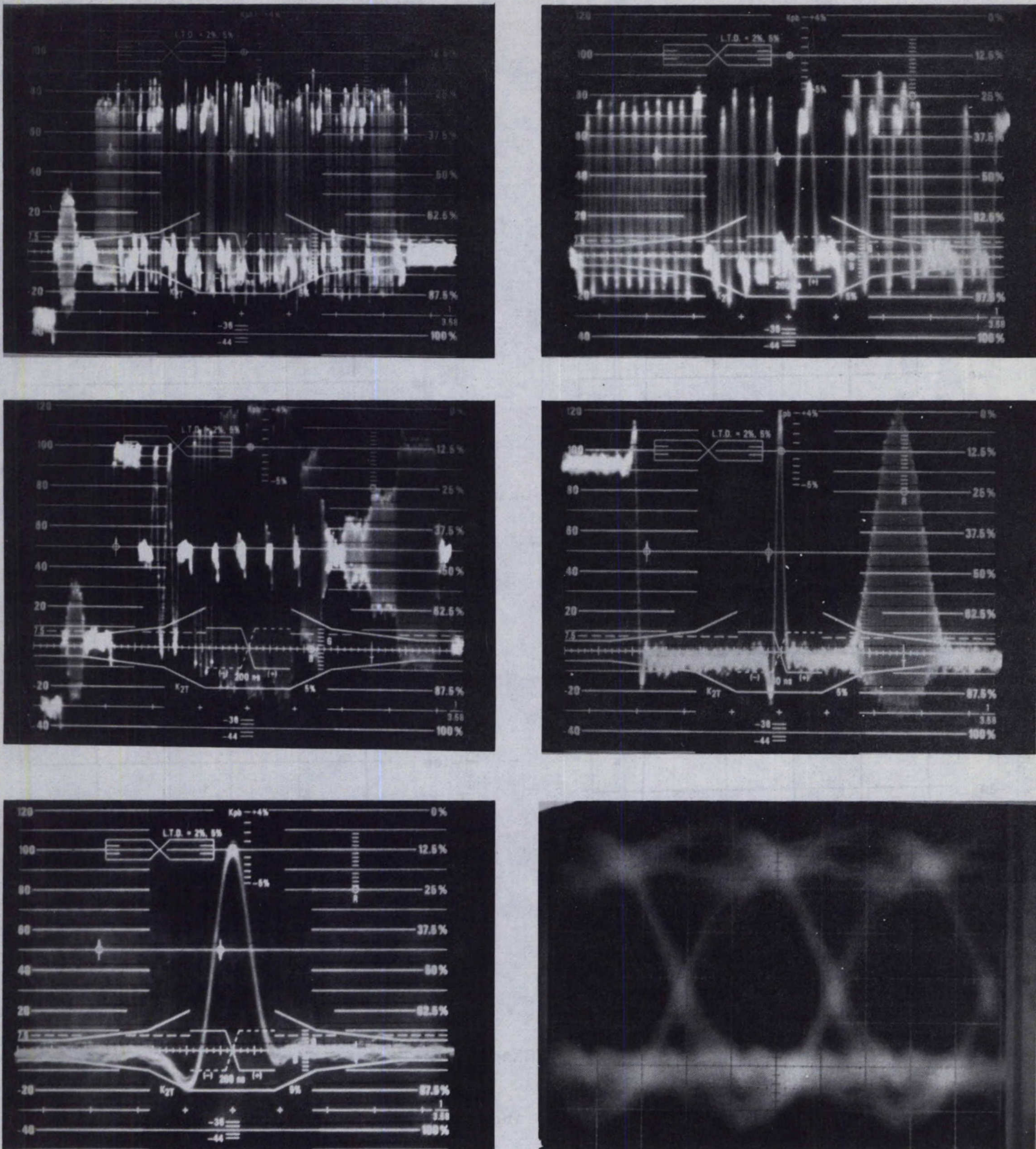


Figure 4.9: System No 2, TP-4, Channel 15

- Photographs of the signal received at the end of a trunk (AML link of 5.1 km + 24 amplifiers). R & S synchronous demodulator.

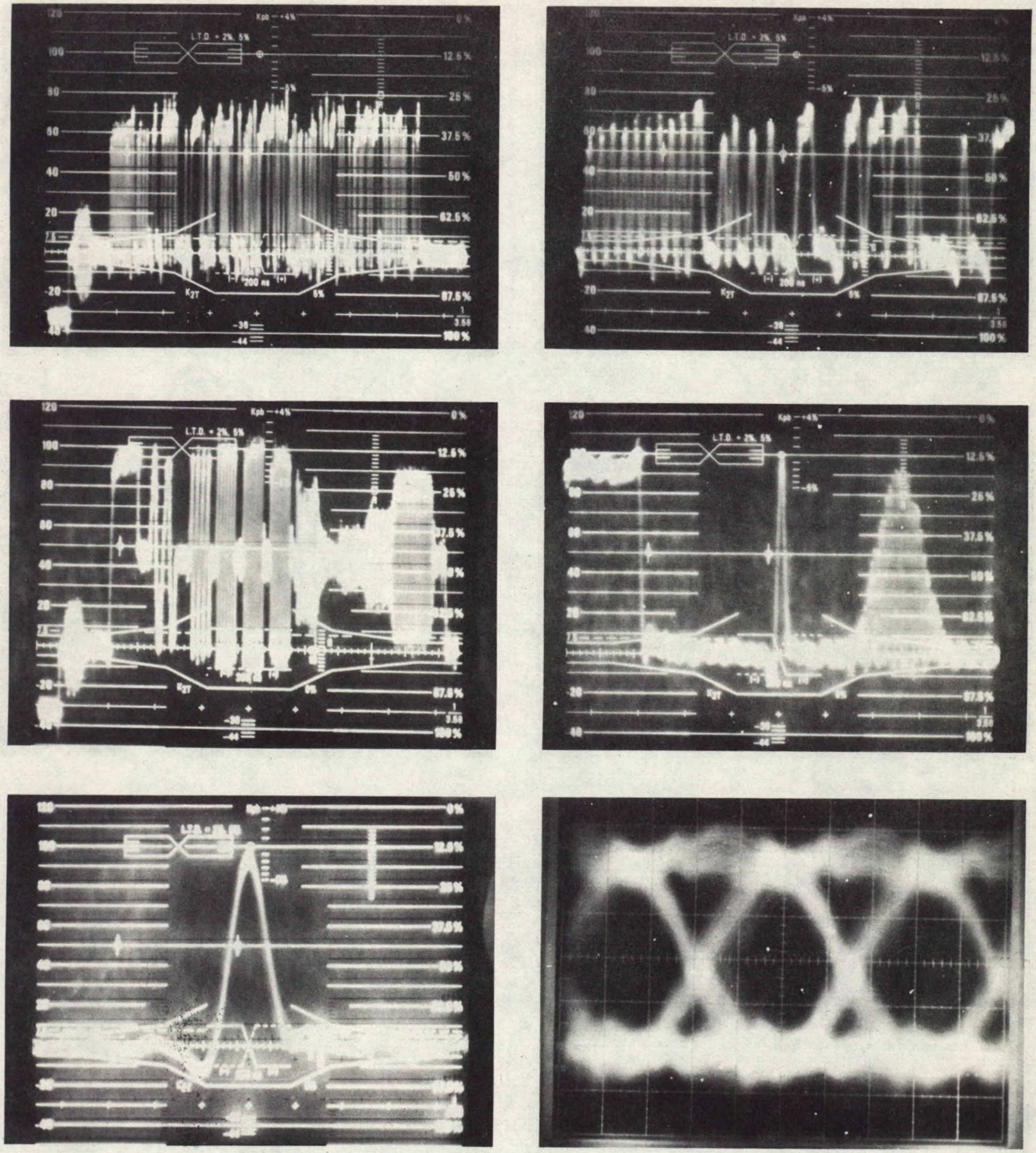


Figure 4.10: System No 2, TP-4, Channel 16

- Photographs of the signal received at the end of a trunk (AML link of 5.1 km and 24 amplifiers). R & S synchronous demodulator.

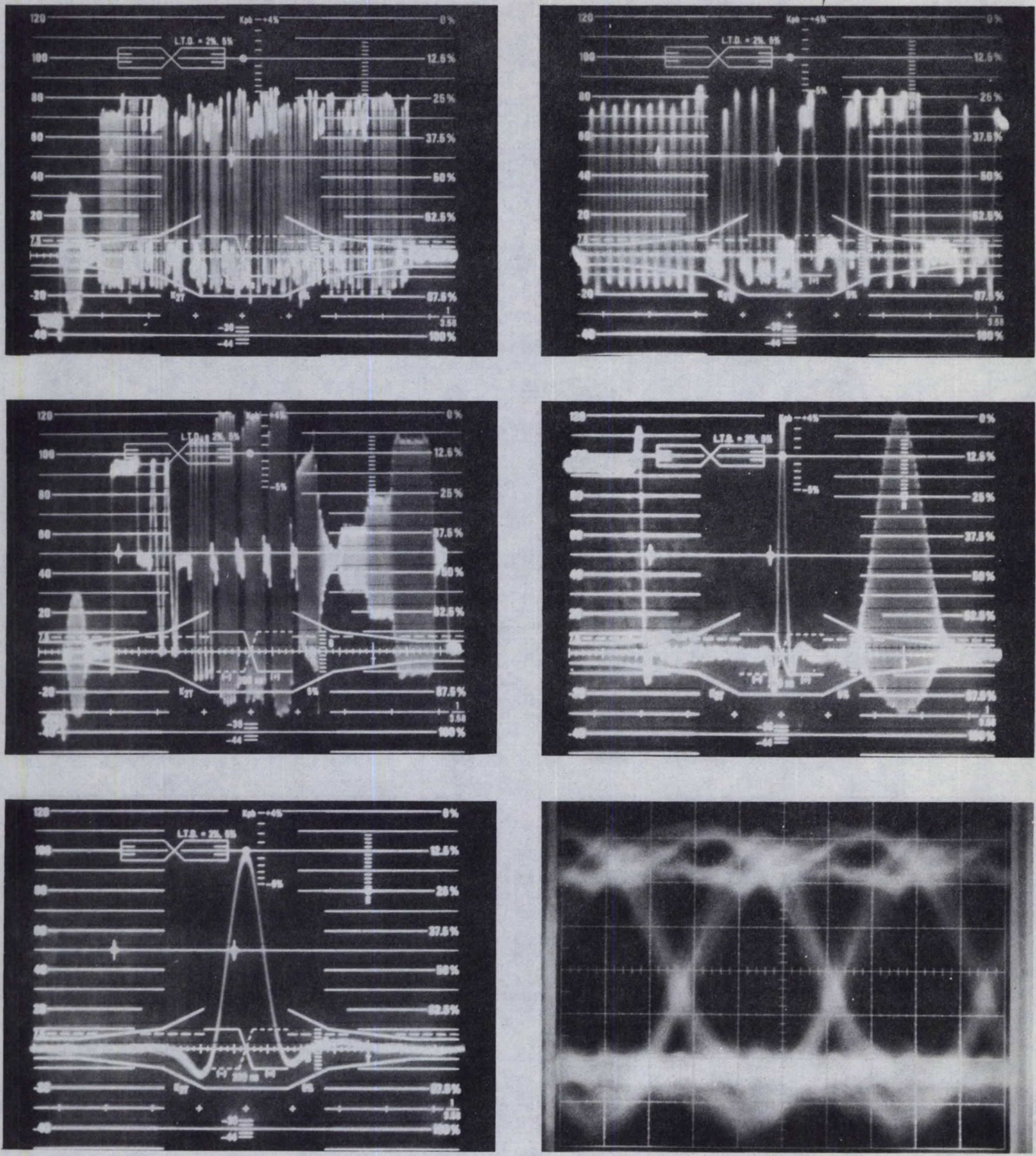
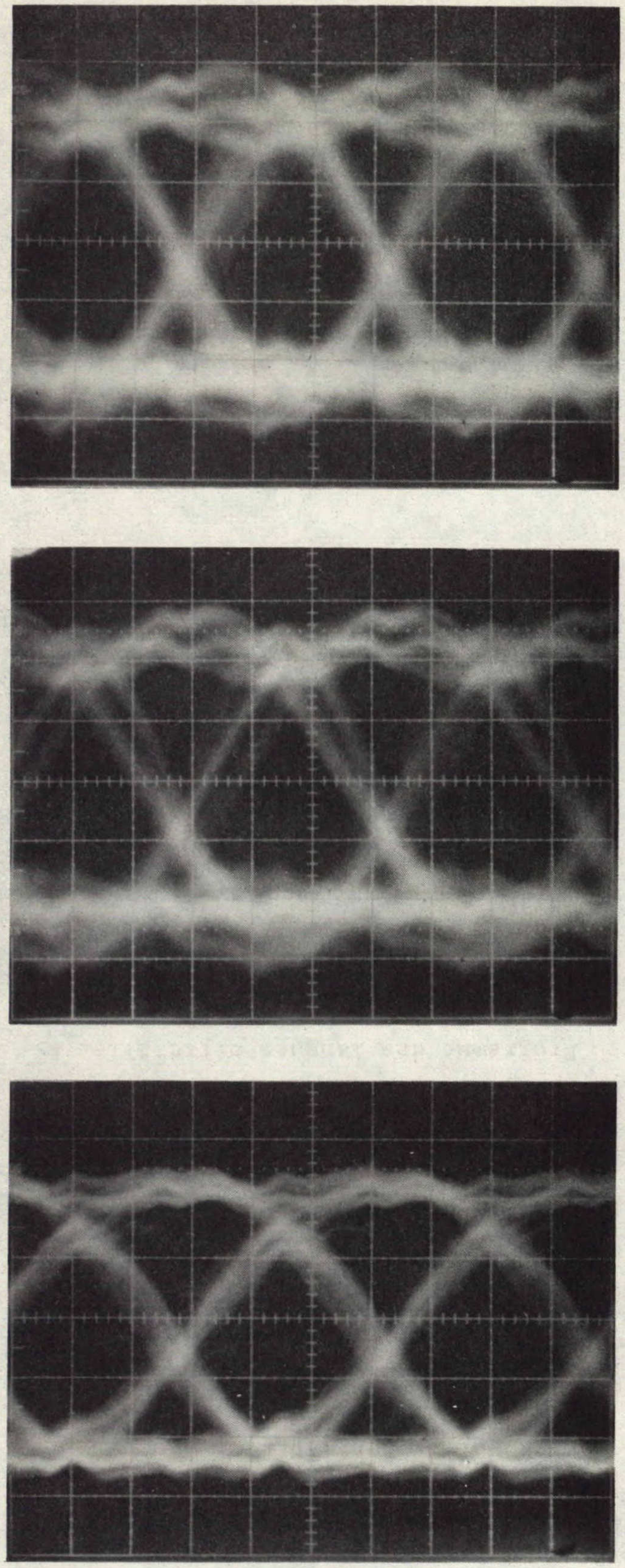


Figure 4.11: System No 2, TP-5, Channel 16

- Photographs of the signal received at AML reception site No 2 (AML link of 15.2 km). R & S synchronous demodulator.



(a) R & S in synchronous mode

(b) R & S in envelope mode

(c) Electrohome receiver

Figure 4.12: System No 2, TP-7, Channel 16
- Photographs of the eye diagrams obtained with the different demodulators used.

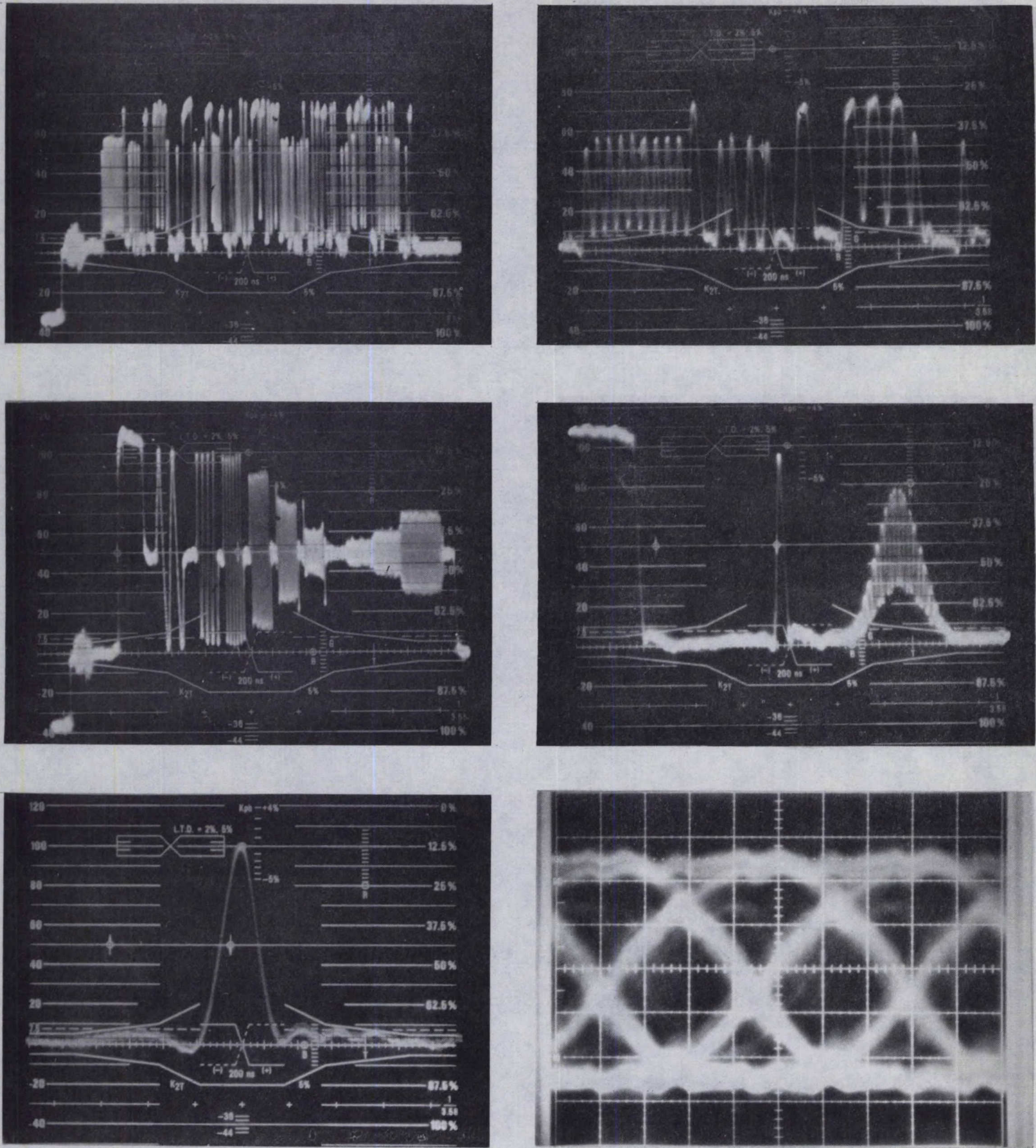


Figure 4.13: System No 2, TP-8, Channel 16
- Photographs of the signal demodulated by the Electrohome television set.

5 CONCLUSIONS

In general, there was excellent reception of a 5.72 Mbits/sec teletext signal inserted at the headend of two cable television systems. With the Rohde & Schwarz demodulator in synchronous mode and the Electrohome television set, reception of the 5.72 Mbits/sec teletext signals was rated excellent at more than 95% of the test points.

The most important factor causing deterioration of the teletext signal on System No 1 was the problem of multiple echoes. At certain test points, the echo signal exceeded the permissible levels set by BP-23. At the same points, the quality of reception of the teletext signal ranged from excellent with the R & S synchronous demodulator to poor with the R & S envelope detector. The echo rating described in BP-23 was determined using subjective evaluations of picture impairment (normal video) and does not apply to the teletext signal. Nevertheless, in the cases encountered, reception of the teletext signal was excellent when the echo rating was less than 7% (limit specified in BP-23).

Of course, the echo problems encountered on System No 1 do not represent a normal situation. They were caused by an underground cable that had been damaged accidently. However, since it is sometimes difficult to make immediate repairs, temporary echo problems are still important. They can disrupt the teletext signal for long periods of time while not appreciably affecting the video picture. A special study will be made of the echo problem.

The reception of a teletext signal at the end of a trunk with 43 cascaded amplifiers was also tested. In spite of a signal-to-noise ratio of 31 dB, the reception quality at the end of the trunk was excellent with the R & S demodulator in synchronous mode.

The low-power (System No 1) and the high-power (System No 2) microwave links used during this study were relatively transparent. Only one of the four channels tested (Channel 15, System No 2), displayed a poor frequency response. The problem appears to have been caused by poor tuning of the AML transmitter. A report on the performance and possible problems associated with AML transmitters is currently being drafted.

Three types of demodulators were used in this study. Two of them, the R & S in synchronous mode and the Electrohome television set (especially modified for teletext and fitted with a quasi-synchronous detector) gave excellent results. The R & S demodulator in envelope mode displayed a few weaknesses at the test points where there were significant echoes and noise. The quadrature distortion caused by the demodulation of the envelope of a VSB (vestigial side band) signal explains the poor performance of this mode of demodulation.

The technical limitations of the Norpak Mark III decoder are an important factor to be considered in interpreting the results of this study. In several instances, the line loss rate was directly related to the synchronization circuit of the Mark III. At TP-5, for example, on Channel 15 of System No 2, the bit error rate was zero while the line loss rate was 20% with the R & S demodulator in envelope mode. This was apparently caused by undershoots of the teletext signal which prevented the Mark III from maintaining perfect synchronization. This particular problem should be overcome by the Norpak Mark IV which uses a different synchronization system. We can therefore expect the results with the Mark IV to be significantly better than those obtained with the Mark III.

It was apparent, in this study as in previous ones, that the provisions of BP-23 are not always met by cable television systems. Although there is not always an appreciable effect on the quality of the video image, non-compliance can significantly interfere with the quality of the teletext signal.

The general conclusion from this study is that cable television systems can provide an excellent teletext service at a digital rate of 5.72 Mbits/sec, provided that the systems comply with existing standards.

6 RECOMMENDATIONS

The following recommendations are based solely on the results obtained during this study. They will therefore have to be considered in light of the recommendations made following other studies, computer simulations, theoretical studies and current technological limitations.

1- That BP-23 be regarded as an essential pre-requesite for channels used to transmit a 5.72 Mbits/sec teletext signal.

2- That the cable broadcaster regenerate the teletext signal received off-air at the headend if the signal quality does not meet a certain minimum standard. This minimum standard is still to be established. For example: eye height $\geq$ 75%, echo rating < 3%, S/N $\geq$ 40 dB.

3- That a deghosting equalizer be built into all future teletext decoders.

4- That specific standards and procedures be established for teletext transmission. These standards should cover the following characteristics:

- echo rating established specifically with respect to the 5.72 Mbits/sec teletext signal;
- frequency response (amplitude and phase) of the channel; this would involve a testing technique to give information on the amplitude and phase of the entire video signal;
- standardization of a technique for measuring the eye height, and development of an instrument which would give an eye height measurement that could reflect the quality of the signal received.

Bouchard, Magella
Evaluation of the reception quality of a 5.72 Mbits/sec teletext signal on cable television systems.

DATE DUE

JAN 20 1993			