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FINAL REPORT

INVESTIGATION OF F-I MRIR

Contract NAS 5-757

For - National Aeronautics and Space Administration
Goddard Space Flight Center
Aeronomy and Meteorology Division
Greenbelt, Maryland

2 November 1964

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FINAL REPORT

INVESTIGATION OF F-1 MRIR

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Contract NAS 5-757
SBRC Project 2060

2 November 1964

Prepared by F. R. Malinowski Approved by R. F. Hummer

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Systems Engineering

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TABLE OF CONTENTS

SBRC

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Cont)

LIST OF TABLES

Section 1
HISTORY

The F-1 MRIR was delivered to the University of Michigan in November 1962 for special high-altitude balloon and aircraft flight testing.

In June 1963, just prior to the balloon flight test, the F-1 MRIR developed chopper bearing trouble and was returned to SBRC for repair. The radiometer chopper assembly bearings were replaced, the chopper blade repinned, and the MRIR channel gains adjusted so that the MRIR would have the same calibration that it initially had.

The radiometer was then returned to the University of Michigan for the balloon flight tests and subsequent aircraft testing. In June 1964, at the completion of all special testing, the F-1 MRIR was returned to SBRC.

Just prior to its return to SBRC, the radiometer was sent to NASA (Goddard Space Flight Center) where check of calibration measurements were performed. During these calibration measurements, the 10- to 11-micron channel was observed to have an erratic behavior.

Upon its return to SBRC, an investigation was started to determine the cause of the erratic behavior of the MRIR 10- to 11-micron channel. In addition, check of calibration measurements were made to determine the extent that the radiometer calibration had changed from the original calibration at SBRC.

This report covers the investigation that was made, the results that were obtained, and the conclusions that were reached.

Section 2

SUMMARY OF RESULTS AND CONCLUSIONS

1. A calibration change was found to exist in the 5- to 30-micron channel. This change was found to be the result of a decrease in gain of approximately 5% in the scanner, and was traced to a decrease in transmission in the 5- to 30-micron optical filter.

It is felt that the filter transmission change may, in part, have been the result of UV radiation on the filter during the balloon and aircraft flight tests, since the high-infrared, low-UV reflecting optics had not been installed in this radiometer.

2. A change in calibration was found to exist in the 6.7-micron channel. This change was found to be the result of an increase in gain in the scanner (which continued to increase during testing) and was traced to a small piece of an interference layer on the 6.7-micron filter peeling off — increasing the transmission of the "filter skirts."

The interference layer that failed had been hermetically sealed.

The cause of the filter failure has not been determined.

3. The check of calibration of the 0.2- to 4.0-micron channel was found to be in good agreement with the original calibration.

4. A calibration change was found to exist in the 0.55- to 0.85-micron channel. The change was found to be the result of a decrease in transmission of the 0.55- to 0.85-micron filter. The filter suffered from what appeared to be polymerization of the balsam cement which bonds two elements of the filter together.

This failure mode was found to exist in this filter type during the NIMBUS program, and has been corrected for the P-2 prototype MRIR and the F-2 and subsequent flight MRIR's.

The F-1 MRIR had been shipped prior to incorporating the corrected action.

5. The output capacitors and Zener diode of the 10- to 11-micron channel were found damaged. The shells of the two line-to-ground capacitors were ruptured and the glass diode was shattered. On the basis of tests performed, it is believed that the capacitors and diode were damaged by the application of a reverse polarity voltage across the output lines of this channel.

The failure produced an intermittent and varying load on the output voltage of this channel and resulted in the erratic behavior reported by NASA.

6. The current leakage of the output capacitance circuit for three of the remaining channels was found to be excessively high.

The cause of this increased current leakage in the capacitors is unknown.

7. A small piece of the short-wavelength attenuating (blocking) interference layer of the 10- to 11-micron filter had peeled off. This layer is used to attenuate wavelength "harmonics" of the bandpass element.

This failure may have occurred as a result of condensed water collection on this filter.

8. The transmission of the 10- to 11-micron filter in the 9- to 12-micron region was found to have decreased approximately 10% from the original transmission measurements made on this filter. The cause of this decrease is unknown.

9. A small, intermittent change in the amplitude of the offset voltage in the 10- to 11-micron channel was found to exist. The observed change amounted to 0.5 volt.

Because of its intermittency the cause of this change has not yet been isolated.

10. The reported decrease in torque output in the scan mirror drive assembly was found to be the result of an intermittent open in the No. 2 phase scan motor power wire in the interconnecting test cables that had been used.

Section 3

INITIAL INVESTIGATION AND CHECK OF CALIBRATION

When the radiometer was delivered to SBRC by NASA it was reported by NASA that the MRIR scan mirror had become contaminated[1] just after the calibration tests at NASA had been completed and would require cleaning. The scan mirror was examined, found to require cleaning, and was cleaned. (A translucent layer of grease or oil appeared to be deposited on the scan mirror.)

The primary and secondary optics did not suffer from the contamination observed on the scan mirror. They had a thin layer of dust deposited on them and what appeared to be small "water speck" stains.

Because it would have been necessary to partially disassemble the scanner and remove the lens deck assembly in order to give the primary and secondary optics a thorough cleaning, only a light cleaning was performed using a soft camelhair brush to remove the thin layer of dust. It was felt at the time that any work done on the radiometer should be kept to a minimum, prior to obtaining check of calibration data and failure inspection, to reduce the possibility of changing the MRIR characteristics or parameters.

The MRIR was connected and powered while in a laboratory environment and the scan mirror drive was investigated for any loss in torque, since it had been reported (by the University of Michigan) that on several occasions the scan mirror did not start turning when power was applied, and required

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[1] This resulted from the overheating of the blackbody calibration target, due to a faulty heating switch, while the system was in a vacuum chamber — causing outgassing of contaminants (at the elevated temperature) which were deposited on the MRIR scan mirror.

a small amount of "hand-torque" to get it started. No problem was encountered in starting the scan mirror and the torque appeared normal.

A later investigation of the University of Michigan's interconnecting test cables uncovered an intermittent open in the No. 2 phase scan motor power wire (at connector J301 pin 1), which explained the reported difficulty.

The radiometer scanner was placed in a thermal vacuum chamber and a check of calibration measurement was made at 25°C temperature. The check of calibration run was then rerun to determine the repeatability of the readings.

With the exception of the 10- to 11-micron channel, which varied unexplainably between and during the runs, the data from all of the channels were repeatable within experimental error.

Listed in Table 1 is a comparison of the readings for the two runs. These data are plotted[2] in Figures 1 through 5 along with the original calibration curves[3] for the MRIR obtained in November 1962.

Examination of the 5- to 30-micron channel data in Figure 1 shows that the change in calibration that occurred since the original calibration is primarily one of gain in the scanner[4] and not of offset voltage (chopper radiation

[2] Except for the 10- to 11-micron channel, the best fit curves are plotted rather than the actual data points for illustration clarity.

[3] The curves for the 0.55- to 0.85-micron and 0.2- to 4.0-micron channels have been corrected for the 30% and 10% errors (respectively) that were found in the albedo targets subsequent to the original calibration of F-1 (see Twelfth Quarterly Report, Five-Channel Scanning Radiometer, for 15 July to 15 October 1963).

[4] If the gain change had occurred in the electronics module, the crossover point of the curves would have occurred at zero voltage output.

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Table 1. Comparison of Check of Calibration Data Obtained on F-1 MRIR on Two Successive Days (Scanner at 25°C Temperature)

Target Temperature (°C)	Channel 5- to 30-Micron (vdc)		6.7-Micron (vdc)		10- to 11-Micron (vdc)	
	1	2	1	2	1	2
-93	-10.9	-10.8	-6.65	-6.5	-10.0	-11.0
-83	-10.65	-10.5	-6.5	-6.4	- 9.8	-10.75
-73	-10.25	-10.25	-6.25	-6.25	- 9.6	-10.6
-63	- 9.8	- 9.75	-6.1	-6.0	- 9.0	-10.25
-53	- 9.4	- 9.4	-5.7	-5.7	- 9.0	- 9.9
-43	- 8.8	- 8.85	-5.25	-5.25	- 9.3	- 9.5
-33	- 8.25	- 8.25	-4.5	-4.55	- 8.8	- 9.0
-23	- 7.5	- 7.5	-3.65	-3.7	- 8.25	- 8.25
-13	- 6.75	- 6.7	-2.45	-2.5	- 7.4	- 7.35
- 3	- 5.75	- 5.75	-1.0	-1.0	- 6.25	- 6.5
+ 7	- 4.75	- 4.75			- 5.4	- 5.25
+17	- 3.65	- 3.6			- 4.0	- 4.1
+27	- 2.45	- 2.4			- 2.75	- 2.75
+37	- 1.00	- 1.0			- 1.0	- 1.15
+42	- 0.30	- 0.3			- 0.3	- 0.35
+47					+ 0.75	+ 0.75

Albedo (%)	Channel 0.55- to 0.85-Micron (vdc)		0.2- to 4.0-Micron (vdc)	
	1	2	1	2
10	- 1.35	- 1.35	1.2	1.25
20	- 2.65	- 2.6	2.5	2.5
30	- 3.9	- 4.0	3.75	3.75
40	- 5.2	- 5.35	5.0	5.0
50	- 6.5	- 6.5	6.3	6.35
60	- 7.75	- 8.0	7.6	7.7
70	- 9.3	- 9.1	9.0	9.0
80	-10.5	-10.5	10.25	10.2

compensation) shift. This is indicated by the two calibration curves crossing at a temperature approximately equal to the scanner temperature. The magnitude of this gain change is approximately -4%.

Examination of the 6.7-micron channel data in Figure 2 suggests that the change in calibration that has occurred is also primarily the result of a gain change in the scanner. This is shown by projecting the original calibration into the positive MRIR voltage output plane along the theoretically expected response curve (dotted extension) and extrapolating the recent calibration curve along a similarly shaped response curve. The intersection of these two curves occurs at a temperature approximately equal to the scanner temperature. The magnitude of the gain change is calculated to be approximately +12.5%.

Examination of the 0.2- to 4.0-micron channel data in Figure 3 shows that essentially no change in calibration occurred since the original calibration.

Examination of the 0.55- to 0.85-micron channel data in Figure 4 shows that a gain change of approximately -14% has occurred in this channel since the original calibration.

Figure 5 shows the inconsistency of the data that were obtained for the 10- to 11-micron channel. These data confirmed the report from NASA that an unexplained variation in output voltage occurred in this channel during calibration runs.

A measurement of the output impedance of the 10- to 11-micron channel showed that the impedance was low and varied erratically. It was felt this variation would explain the inconsistency of the data being obtained for this channel and therefore the electronics module was opened up to investigate the source of the trouble.

Section 4
10- TO 11-MICRON OUTPUT CAPACITORS

When the output circuitry of the 10- to 11-micron channel was investigated it was found that the two 0.22-microfarad line-to-ground output capacitors were ruptured and the glass envelope of the output Zener diode (located between the two capacitors) was shattered. See Figure 6.

It was believed that the capacitors were overstressed (perhaps from excessive voltage being inadvertently applied across the capacitors) causing them to explode and that the force of the explosion was large enough to shatter the glass envelope of the diode. This was evidenced by a fine layer of what appeared to be tantalum spread over a 2 x 6 inch area of the circuit board and a discoloration (and coating of tantalum) of the area on the inside cover of the electronics module which was directly above the capacitors.

The exploded capacitors and damaged diode set up a varying and intermittent short condition which loaded the output of this channel and caused the erratic output voltage variation observed in this channel.

The output capacitors (including the line-to-line capacitor) and the Zener diode were replaced in the 10- to 11-micron channel and additional calibration measurements of all channels were made at different scanner and electronics module temperatures.

Section 5

DETAIL EXAMINATION OF CALIBRATION DATA

5- TO 30-MICRON CHANNEL

Figures 7 and 8 compare the check of calibration data obtained with the original calibration data of the 5- to 30-micron channel for a 40°C scanner temperature and the electronics module at a temperature of 25°C and 40°C, respectively. Again a gain change of approximately -5% from the original calibration data can be observed. At this scanner temperature the cross-over point of the curves occurs at 40°C target temperature.

Figures 9 and 10 compare the check of calibration data with the original calibration data for a 0°C scanner temperature and the electronics module at a temperature of 25°C and 0°C, respectively. It can be seen from these figures that approximately the same gain change from the original calibration curves is observed at this scanner temperature (compared with the gain change for other scanner temperatures) and the crossover points occur at approximately 0°C target temperature. (Crossover would be made to occur at exactly 0°C with less than a 1%, of full scale, shift of one of the curves.)

The data for 10°C and 50°C scanner temperatures yielded essentially the same information as that obtained for the other calibration temperatures – approximately a -5% gain change had taken place in this channel.

6.7-MICRON CHANNEL

Figures 11 and 12 compare the check of calibration data obtained with the original calibration data of the 6.7-micron channel for a 0°C scanner temperature and the electronics module temperature of 25°C and 0°C, respectively. Here, the crossover point occurs at approximately 0°C target temperature, and it is therefore more easily seen that a gain change, rather than an offset shift, was primarily the cause of the change in calibration. It can be seen from Figures 11 and 12 that the gain change is actually greater than that measured for the check of calibration run at 25°C scanner temperature (Figure 2) and that the change in gain is greater at 0°C electronics module temperature (with the scanner at 0°C) than at 25°C electronics module temperature.

It was believed that this change was the result of the 6.7-micron channel gain continuing to increase during the testing sequence and that the increase in gain was being stimulated by the temperature cycling of the scanner. This theory was corroborated when a check of calibration run was again made at 25°C scanner temperature and the gain change was found to be higher than the first check of calibration run at 25°C scanner temperature.

Figures 13 and 14 compare the check of calibration data with the original calibration data of the 6.7-micron channel for a 50°C scanner temperature and the electronics module temperature at 25°C and 50°C, respectively. Here again, by extrapolating the calibration curves into the positive MRIR voltage output plane, it can be seen that the calibration discrepancy is primarily the result of a gain change in the scanner. It can also be seen that the gain change is larger for the run with a 50°C electronics module temperature — this run occurred after the run with the module temperature at 25°C.

The data for 10°C and 40°C scanner temperatures yielded essentially the same information as that obtained for the other calibration temperatures — a calibration discrepancy caused by a gain change had occurred in the scanner and the gain change was continuing to occur.

0.2- TO 4.0-MICRON CHANNEL

Figures 15 and 16 compare the check of calibration data with the original calibration data for the 0.2- to 4.0-micron channel for a 50°C scanner temperature and the electronics module temperature at 25°C and 50°C, respectively. Again it can be seen that essentially no change in calibration occurred in this channel. The small variations observed are on the order of magnitude of the calibration test errors.

Figures 17 and 18 compare the check of calibration data with the original calibration data for a 0°C scanner temperature and the electronics module temperature at 25°C and 0°C, respectively.

The data for the 10°C and 40°C scanner temperatures yielded essentially the same information as that obtained for the other calibration temperatures — essentially no change in gain occurred in this channel.

0.55- TO 0.85-MICRON CHANNEL

Figures 19 and 20 compare the check of calibration data with the original calibration data of the 0.55- to 0.85-micron channel for a 50°C scanner temperature and the electronics module temperature at 25°C and 50°C, respectively. Again a calibration change of approximately 10% to 15% can be seen.

Figures 21 and 22 compare the check of calibration data with the original calibration data for 0°C scanner temperature and the electronics module temperature at 25°C and 0°C, respectively. Again the gain change observed is approximately 10% to 15%.

The data for the 10°C and 40°C scanner temperatures yielded essentially the same information as that obtained for the other calibration temperatures — approximately a 10% to 15% gain change occurred in this channel.

10- TO 11-MICRON CHANNEL

The check of calibration data obtained from the 10- to 11-micron channel again showed an unexplainable variation — more so when the electronics module temperature was varied with the scanner temperature than when the electronics module was kept fixed at 25°C. Because of this behavior, it was felt that additional circuitry in this channel might have failed (perhaps as a result of the explosion of the output capacitors). Therefore, it was decided to again look at the circuitry of this channel.

Section 6

INVESTIGATION OF THE 10- TO 11-MICRON CHANNEL CIRCUITRY AND MRIR OUTPUT CAPACITORS

In investigating the 10- to 11-micron channel circuitry it was found that when the 3.9-microfarad line-to-line output capacitor had been replaced, the new capacitor was installed with a reversed polarity. This resulted in a partial breakdown (excessive current leakage) of the capacitor for MRIR high output voltages (particularly at elevated temperatures) which caused a variable load on the output voltage. This, it was felt at the time, explained the results that were obtained in the later check of calibration measurements at the different scanner and electronics module temperatures.

The line-to-line output capacitor was again replaced in this channel.

The output loading due to the capacitors was measured on all channels. Except for the 10- to 11-micron channel, which had new capacitors installed, all channels showed a current leakage which could be measured on a Simpson 260 meter. The resistance values measured are shown in Table 2.

Table 2. MRIR Channel Output Loading Due to Output Capacitors

Channel	DC Resistance (megohms)
6.7-micron	1.5
10- to 11-micron	Unable to read
0.55- to 0.85-micron	3.0
5- to 30-micron	2.7
0.2- to 4.0-micron	25

The loading caused by the capacitance leakage measured would have resulted in less than 0.5% loading on the channels and therefore an insignificant effect on the calibration. However, the fact that three of the channels had reached such a high level of current leakage was of importance since this indicated that the capacitors had deteriorated drastically.

It was felt that the deterioration might have been a shelf-life problem. For this reason, the current leakage was measured of the capacitors purchased at the same time as those in F-1 MRIR and installed in the F-4, F-5, F-6, and S-2 electronics modules. (These modules had been temperature cycled in a thermal vacuum chamber, but had not been subjected to any vibrational or shock environment.) The resistance values measured are shown in Table 3.

These data indicate that a factor other than shelf life was probably the cause of the output capacitor failures in the F-1 MRIR.

Table 3. Current Leakage Due to Output Capacitor Network in F-4, F-5, and F-6 MRIR's and S-2 Spare Electronics

Channel	DC Resistance		
	F-4	F-5	F-6
6.7-micron	Unable to read	Unable to read	39 megohms
10- to 11-micron	Unable to read	Unable to read	Unable to read
0.55- to 0.85-micron	Unable to read	Unable to read	Unable to read
5- to 30-micron	Unable to read	Unable to read	Unable to read
0.2- to 4.0-micron	Unable to read	Unable to read	Unable to read

Electrical stress testing was conducted on capacitors of the same type (150D) and size as those used in the MRIR output filter network to see if the failures (both rupture and current leakage deterioration) could be reproduced.

The capacitors used for these tests had been procured at the same time as those used in the flight model MRIR.

The capacitors were subjected to dc voltages of various amplitude and of both polarities. In addition, ac voltages of various amplitudes were applied when the capacitors were correctly biased.

Rupturing of the capacitors could only be achieved when the capacitors were back biased with a large dc voltage. The magnitude of the required voltage to cause rupturing varied between -20 and -30 volts. In some instances, at voltage levels slightly below those causing complete failure of the capacitor, a deterioration of the capacitor leakage was observed.

Based on these results, it is felt that the inadvertent application of an external "negative" dc signal across the output lines of the 10- to 11-micron channel could explain the failure of the capacitor and Zener diode.

The deterioration of the output capacitors in the other channels could not be explained by these results since the Zener diodes in the output circuits would have shorted out the negative signal and/or been destroyed in the process of doing so.

Section 7
OPTICAL FILTER EXAMINATION

After the check of calibration measurements were made at the different scanner and electronics module temperatures, the preamplifiers were removed from the scanner and the optical filters were examined. In a visual examination of the filters the following discrepancies were observed.

1. A small piece (approximately 2% of the total filter area) of the interference layer facing the optics was found to have peeled from the 10- to 11-micron filter.

2. A small piece (approximately 3% of the total filter area) of the interference layer located on the inside surface of the front filter element of the 6.7-micron filter had peeled. This surface faces the back element of this two-element filter, is separated by a shim from the back element, and is hermetically sealed.

In addition, a small section of this interference layer (approximately 15% of the total surface area) had separated from the substrate on which it had been deposited.

3. The balsam cement, used to hold together the two filter elements of the 0.55- to 0.85-micron filter, had streaks in it. It is believed that polymerization of the balsam cement had occurred.

This failure mode was found to exist in this filter type during the early part of the NIMBUS program, and has been corrected for the P-2 prototype MRIR and F-2 and subsequent flight MRIR's. (See Letter Progress Reports Nos. 24, 25, and 26.)

The F-1 MRIR had been shipped prior to incorporating the corrected action.

The physical appearance of the 5- to 30-micron filter and the 0.2- to 4.0-micron filter appeared to be normal.

Transmission measurements were made on the three thermal channel filters and the 0.55- to 0.85-micron channel filter.

The results of these measurements are plotted in Figures 23 through 26 along with the original transmission curves obtained for these filters.

10- TO 11-MICRON FILTER

The interference layer of the 10- to 11-micron filter that had peeled was the short-wavelength (blocking) attenuator. It is used to attenuate wavelength harmonics of the bandpass element.

The effect of losing a portion of this layer can be seen in Figure 23, which shows a transmission leak occurring between 4.6 and 5.3 microns.

Although this filter layer will pass the required humidity environment, it has been learned that the filter layer is susceptible to damage with liquid water and will flake after being washed with water. Therefore, it is possible that this failure may have been the result of water moisture condensing on the filter during field testing if the filter temperature was ever below the dew point of the surrounding air.

It can also be seen from Figure 23 that a decrease in transmission also occurred in the 10- to 11-micron filter in the 9- to 12-micron region. The cause of this decrease is unknown.

0.55- TO 0.85-MICRON FILTER

It can be seen from Figure 24 that a decrease in transmission of approximately 20% has occurred in the 0.55- to 0.85-micron filter. This is slightly larger than the decrease in apparent gain that was measured for this channel during check of calibration measurements.

It is believed that part of the filter degradation occurred between the initial delivery of the radiometer to the University of Michigan and the time of the chopper bearing failure and repair. Therefore, when the channel gains were adjusted, compensation was made for this degradation so that the MRIR would have the same calibration that it originally had.

5- TO 30-MICRON FILTER

Figure 25 shows that a decrease in transmission of approximately 5% to 10% occurred in this filter over the 8- to 12-micron band. It is believed that this change accounts for the decrease in gain that was measured during the check of calibration measurements.

It is felt that the filter transmission change may, in part, have been the result of UV radiation on the filter during the balloon and aircraft flight tests, since the high-infrared, low-UV reflecting optics had not been installed in this radiometer.

6.7-MICRON FILTER

Figure 26 shows the increase in transmission of the "filter skirts" that occurred in the 6.7-micron filter. This increase in transmission would account for the increase in gain that was observed for this channel.

It is not understood, however, why the increase in transmission of the upper "skirt" occurred, nor why the increases are occurring so close to the transmission band. According to the filter supplier (OCLI), the interference layer (that peeled) is only intended to be the short-wavelength attenuator used to eliminate harmonics of the bandpass element.

To see if this failure mode could be duplicated, a 6.7-micron filter procured at the same time as the one used in the F-1 MRIR was subjected to a temperature shock environment. The filter was temperature shocked from 0°C to 50°C to 0°C, -10°C to 60°C to -10°C, and from -20°C to 70°C to -20°C.

The procedure used was to stabilize the filter at the first temperature in one temperature chamber, then quickly transfer the filter to a chamber which had been stabilized at the second temperature. The filter was examined between runs and also at the end of the tests. No evidence of peeling or flaking of any of the filter interference layers was observed.

Section 8

ADDITIONAL TESTING OF THE 10- TO 11-MICRON CHANNEL

After the output capacitors were again replaced in the 10- to 11-micron channel, check of calibration measurements were once more started on this channel.

During these runs it was observed that an intermittent shift in the offset voltage would occur. The magnitude of this shift was as high as 0.5 volt. Because of this intermittent and random shifting, it was not possible to get a good evaluation of the net gain change that may have occurred in this channel.

Plotted in Figure 27 are the calibration points that were obtained during the 25°C (scanner and module) temperature run. The large decrease in output voltage that occurred between 210°K and 220°K target temperature was accompanied by a 0.5-volt change in the offset voltage.

The cause of this intermittent change in output voltage has not yet been determined.

Section 9
DATA

Included in Appendix B are tables listing the data points obtained during the check of calibration measurements. The original calibration data are given in Appendix C.

SBRC

Appendix A

ILLUSTRATIONS

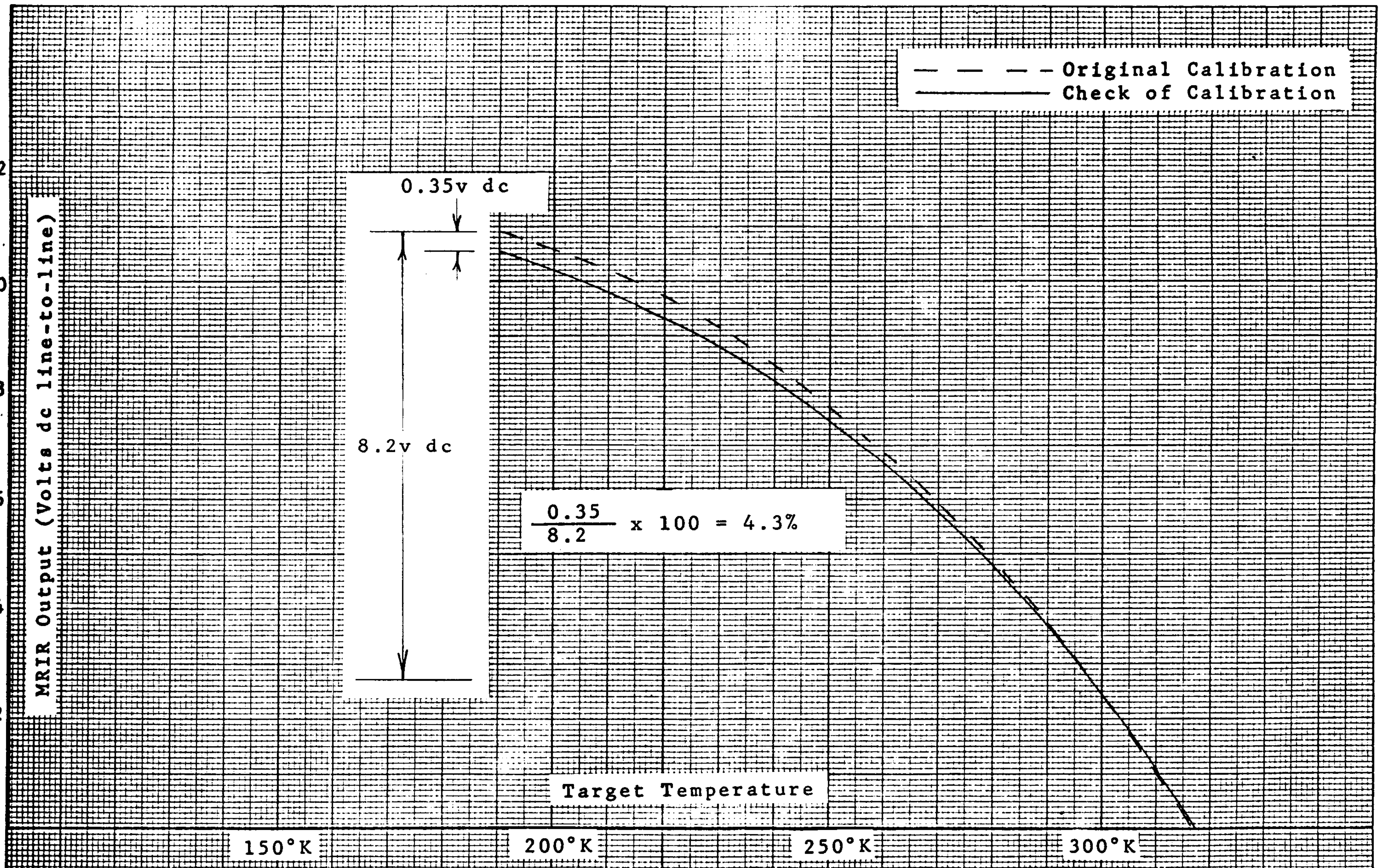

Figure 1 Comparison of Calibration Curves for the 5- to 30-micron Channel. Scanner Temperature 25°C, Module Temperature 25°C.

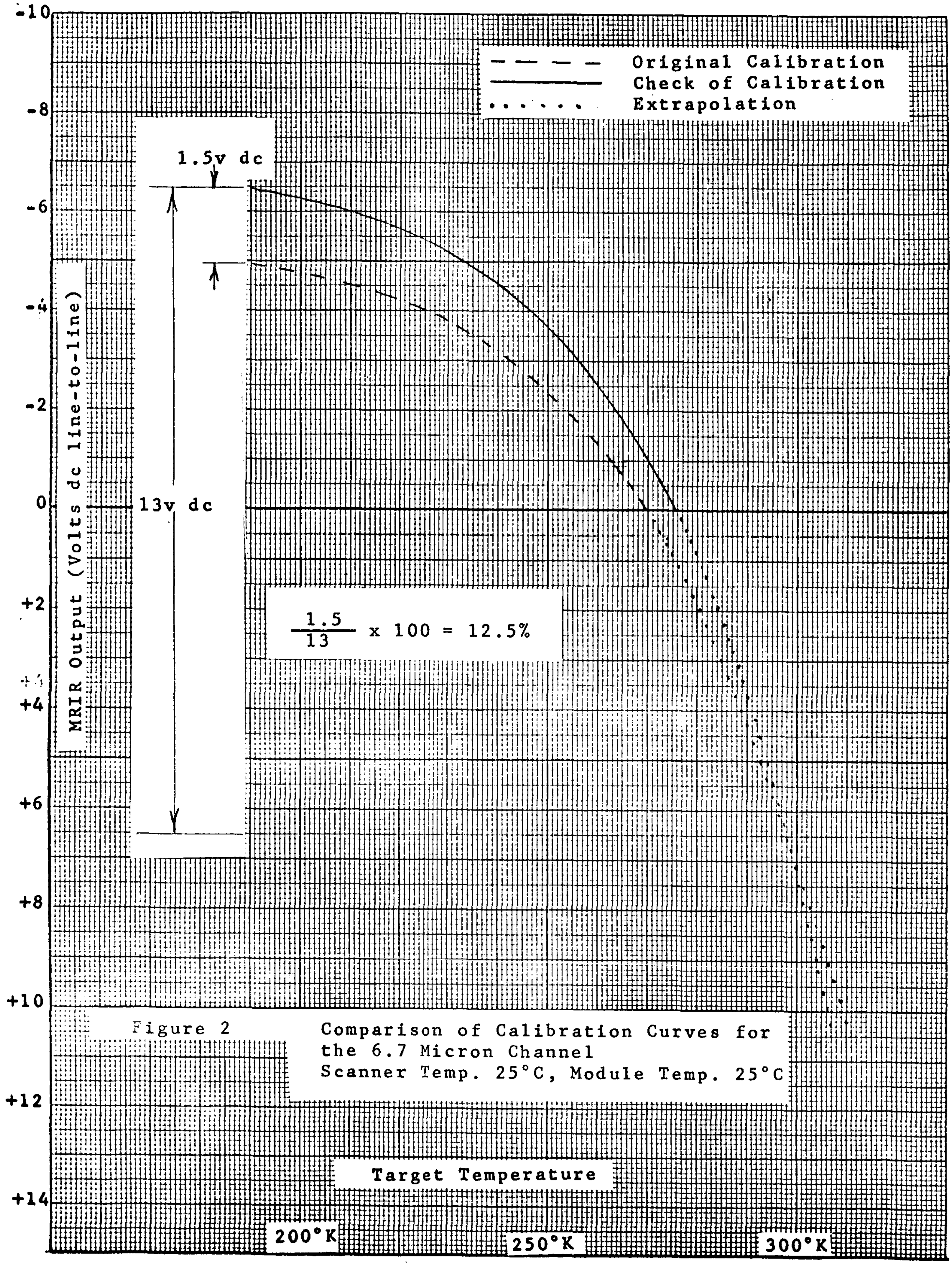

Figure 2 Comparison of Calibration Curves for the 6.7 Micron Channel Scanner Temp. 25°C, Module Temp. 25°C

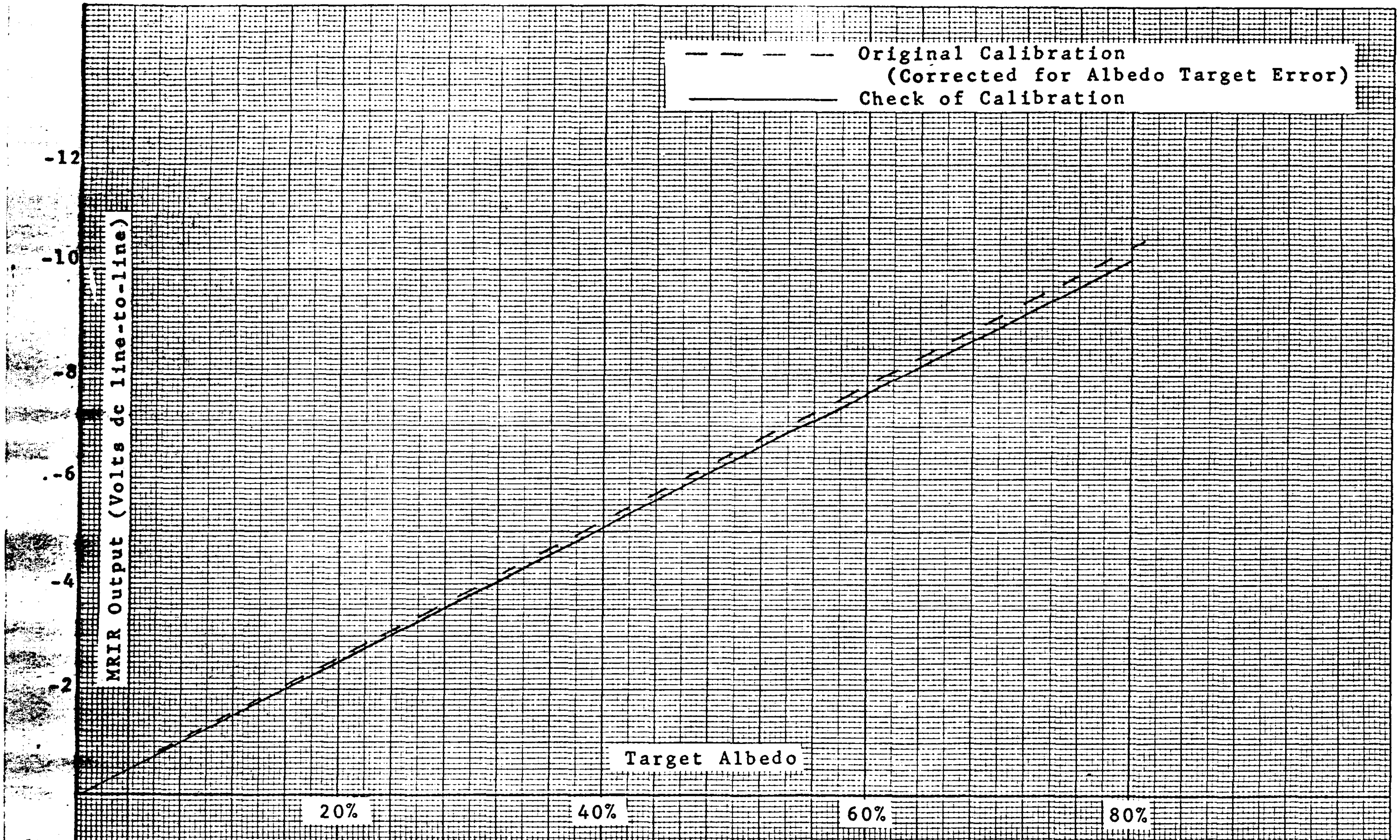

Figure 3 Comparison of Calibration Curves for the 0.2- to 4.0-Micron Channel.
Scanner Temperature 25°C; Module Temperature 25°C

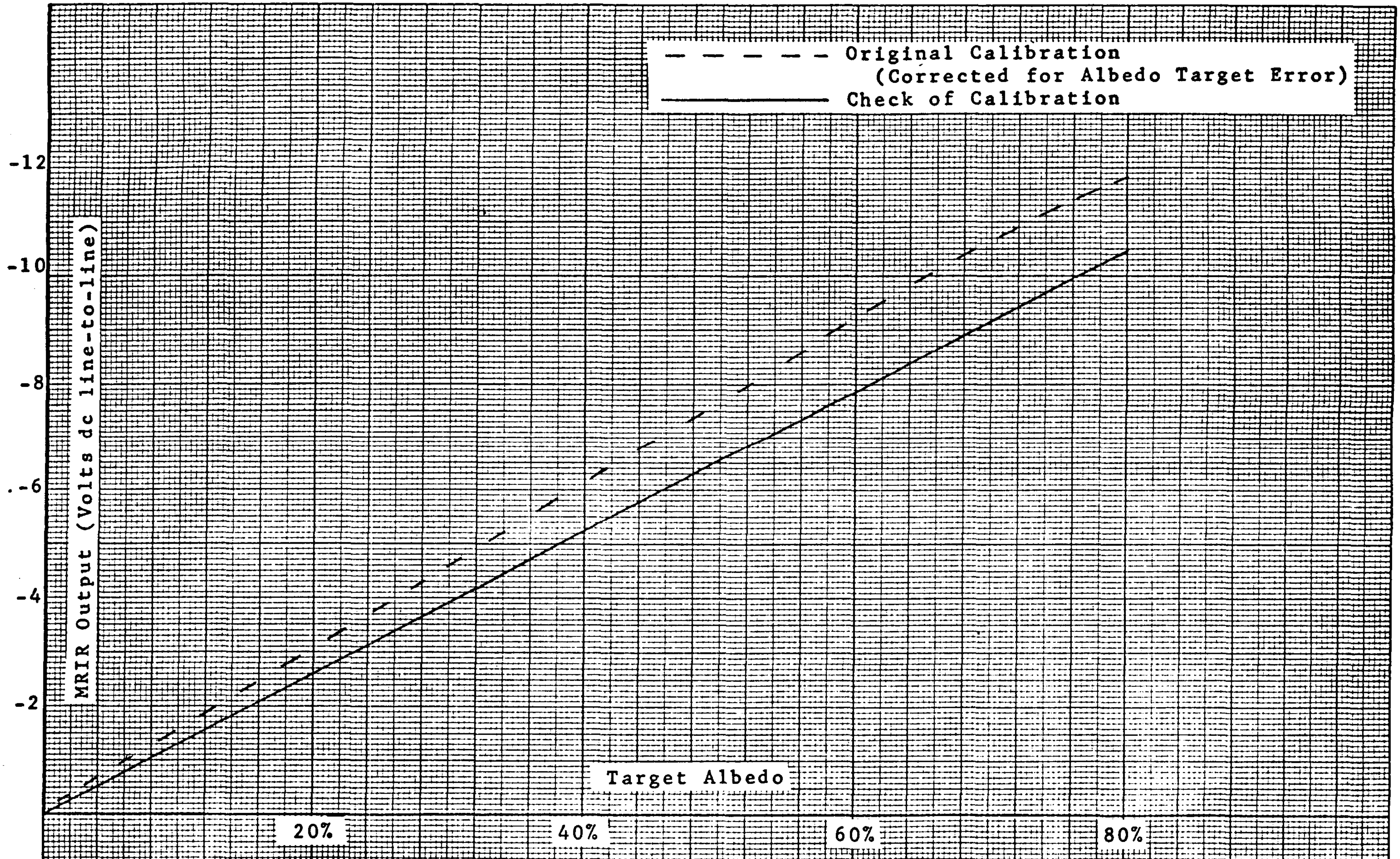

Figure 4   Comparison of Calibration Curves for the 0.55- to 0.85-Micron Channel.
Scanner Temperature 25°C; Module Temperature 25°C

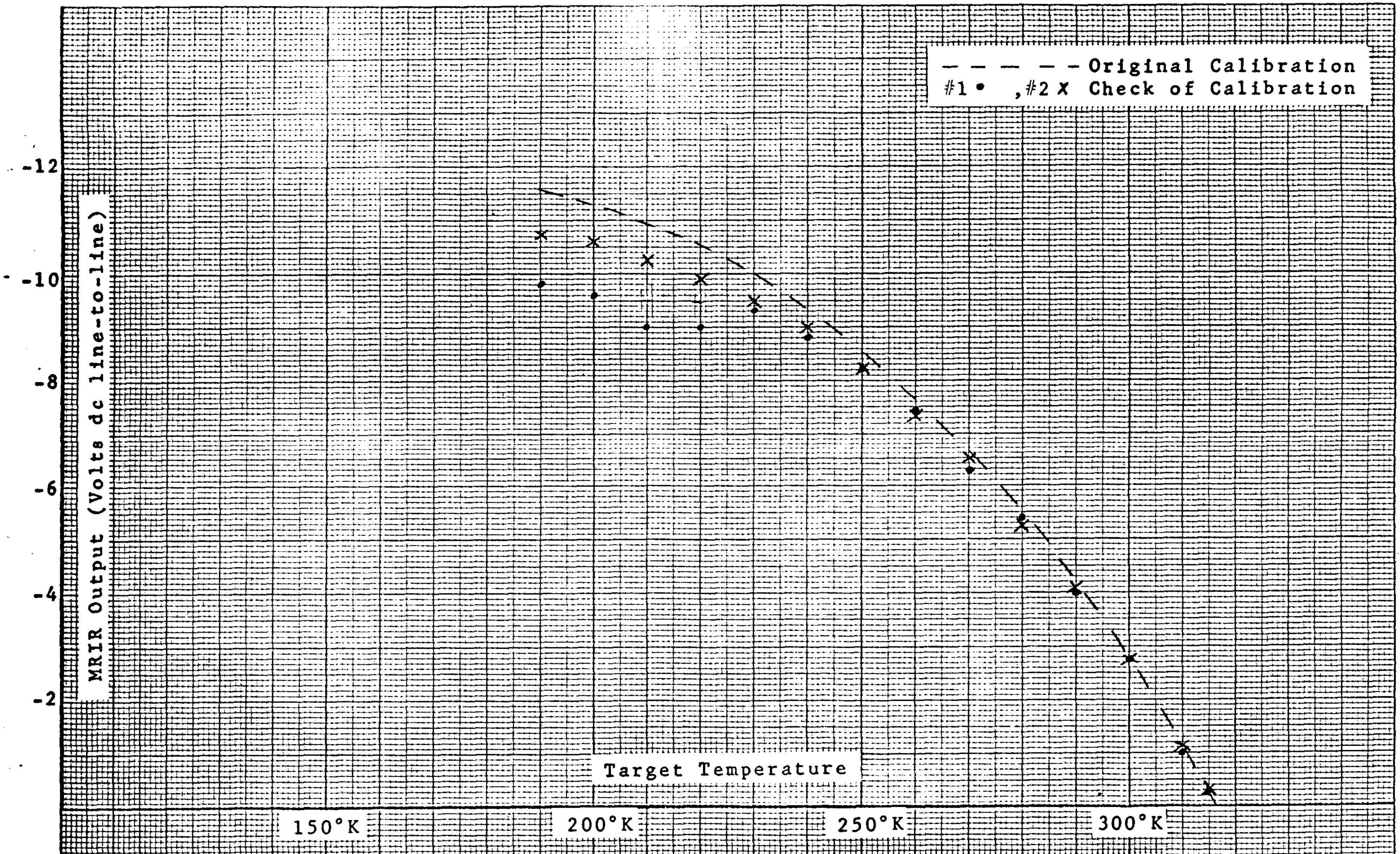

Figure 5 Comparison of Calibration Curves for the 10- to 11-Micron Channel.
Scanner Temperature 25°C; Module Temperature 25°C

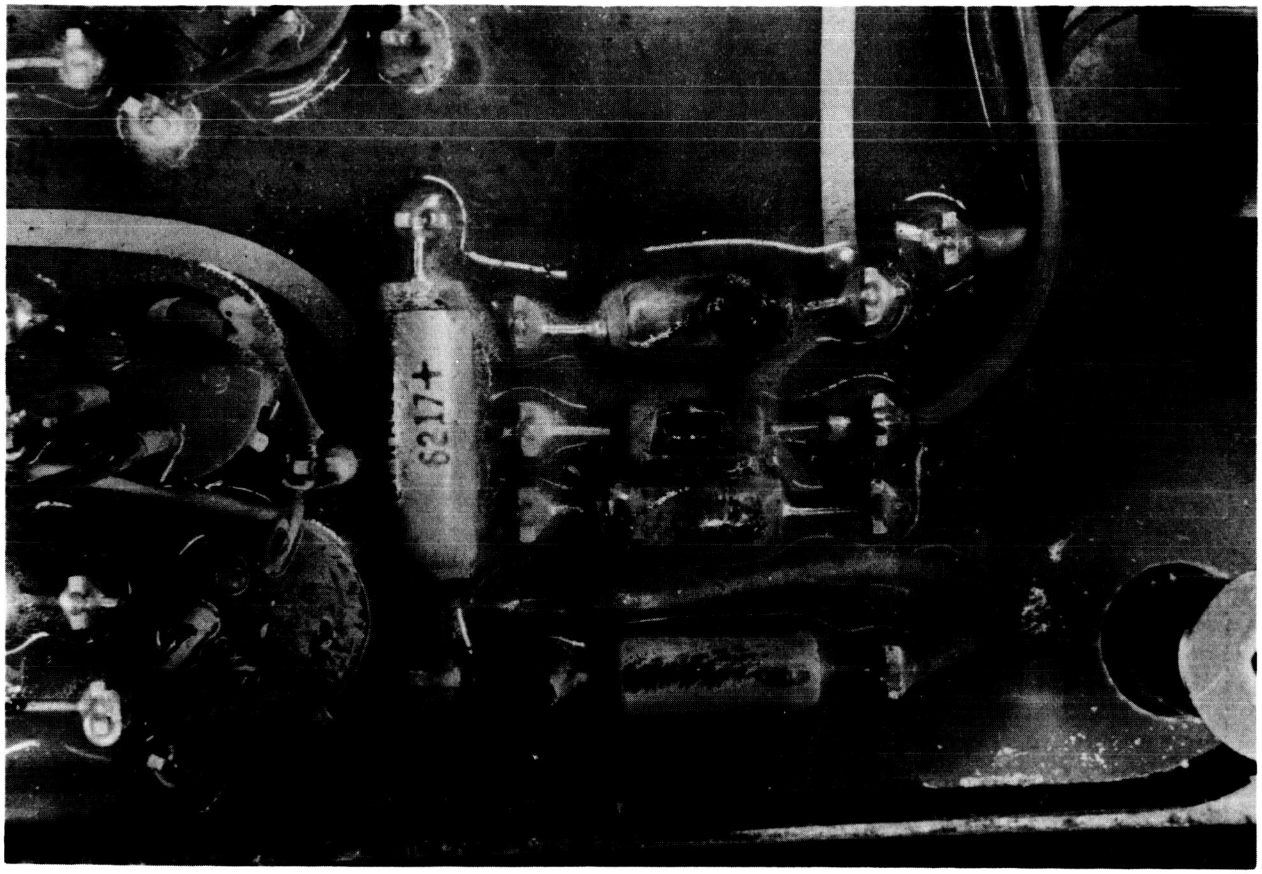

Figure 6

Failure of F-1 MRIR 10- to 11-Micron Channel Line-to-Ground Output Capacitors and Zener Diode

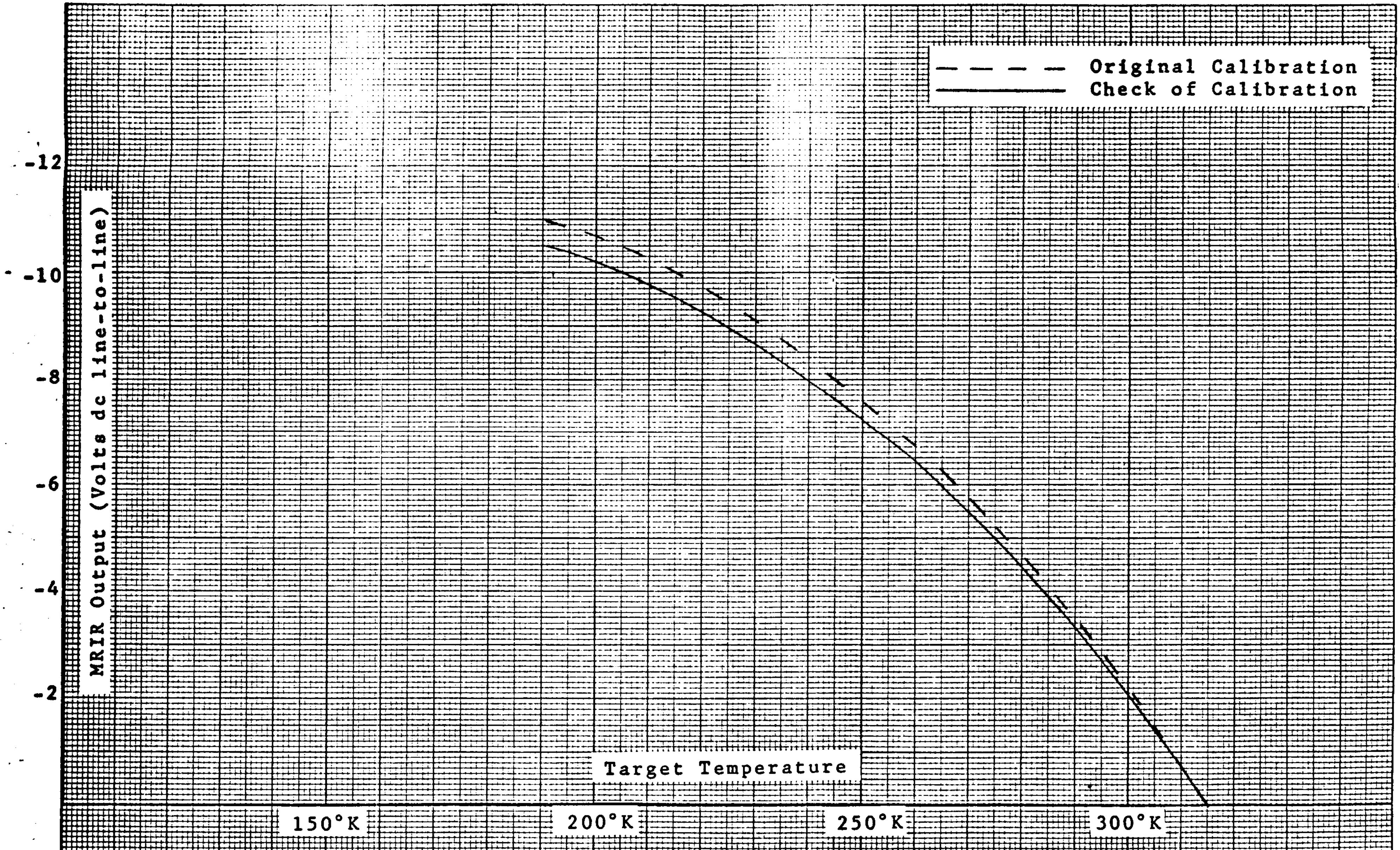

Figure 7 Comparison of Calibration Curves for the 5- to 30-Micron Channel.
Scanner Temperature 40°C; Module Temperature 25°C

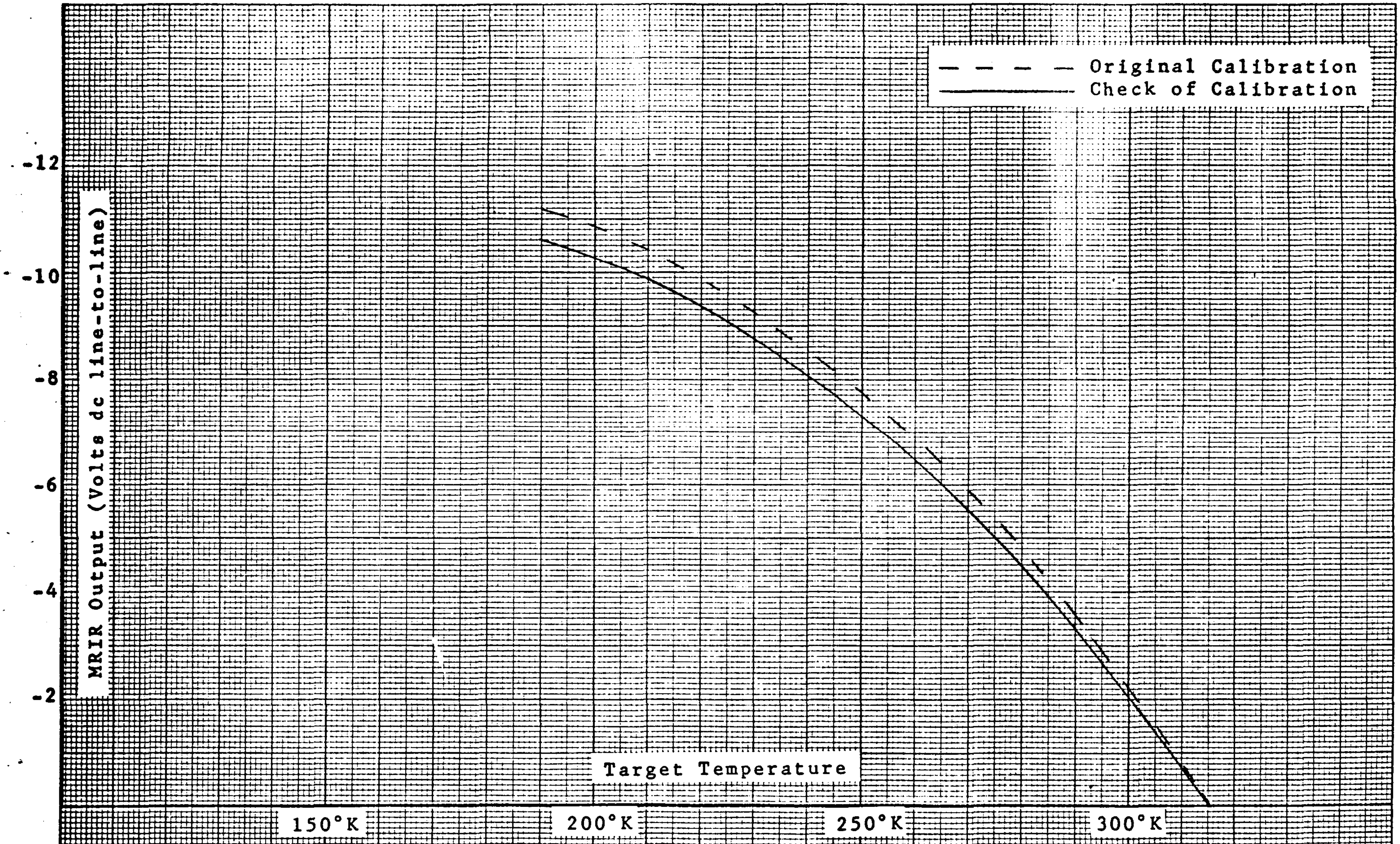

Figure 8 Comparison of Calibration Curves for the 5- to 30-Micron Channel.
Scanner Temperature 40°C; Module Temperature 40°C

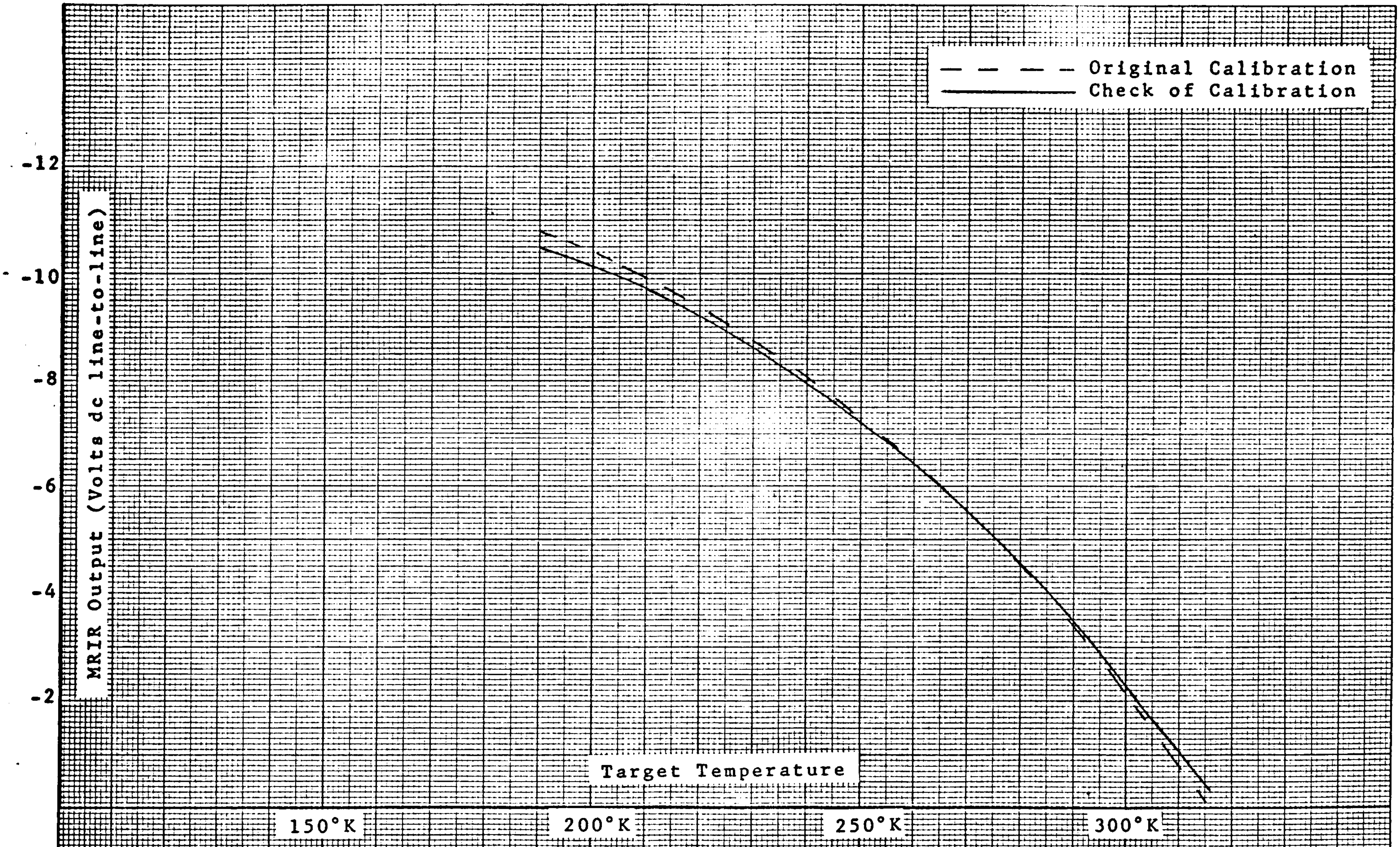

Figure 9 Comparison of Calibration Curves for the 5- to 30-Micron Channel.
Scanner Temperature 0°C; Module Temperature 25°C

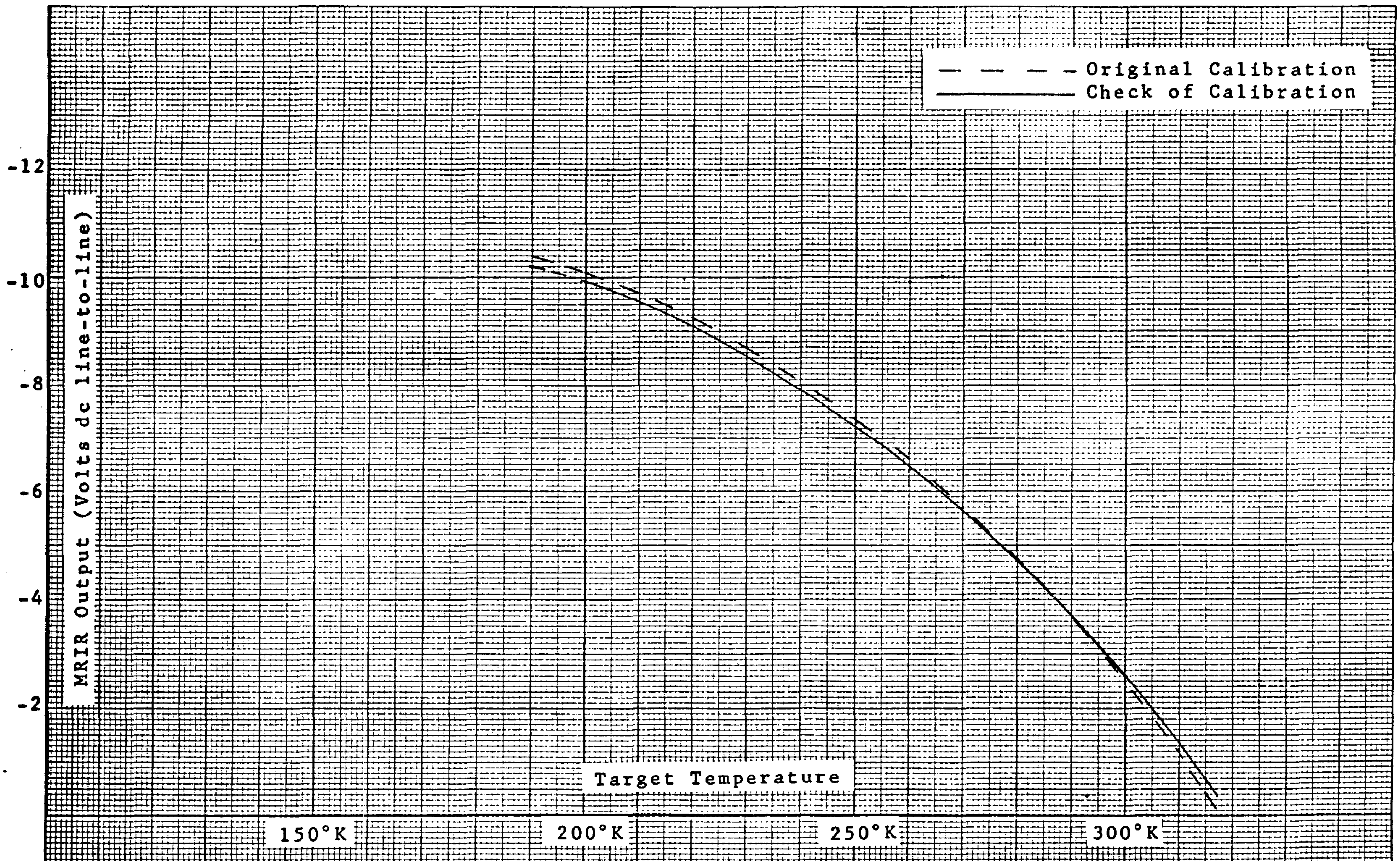

Figure 10 Comparison of Calibration Curves for the 5- to 30-Micron Channel.
Scanner Temperature 0°C; Module Temperature 0°C

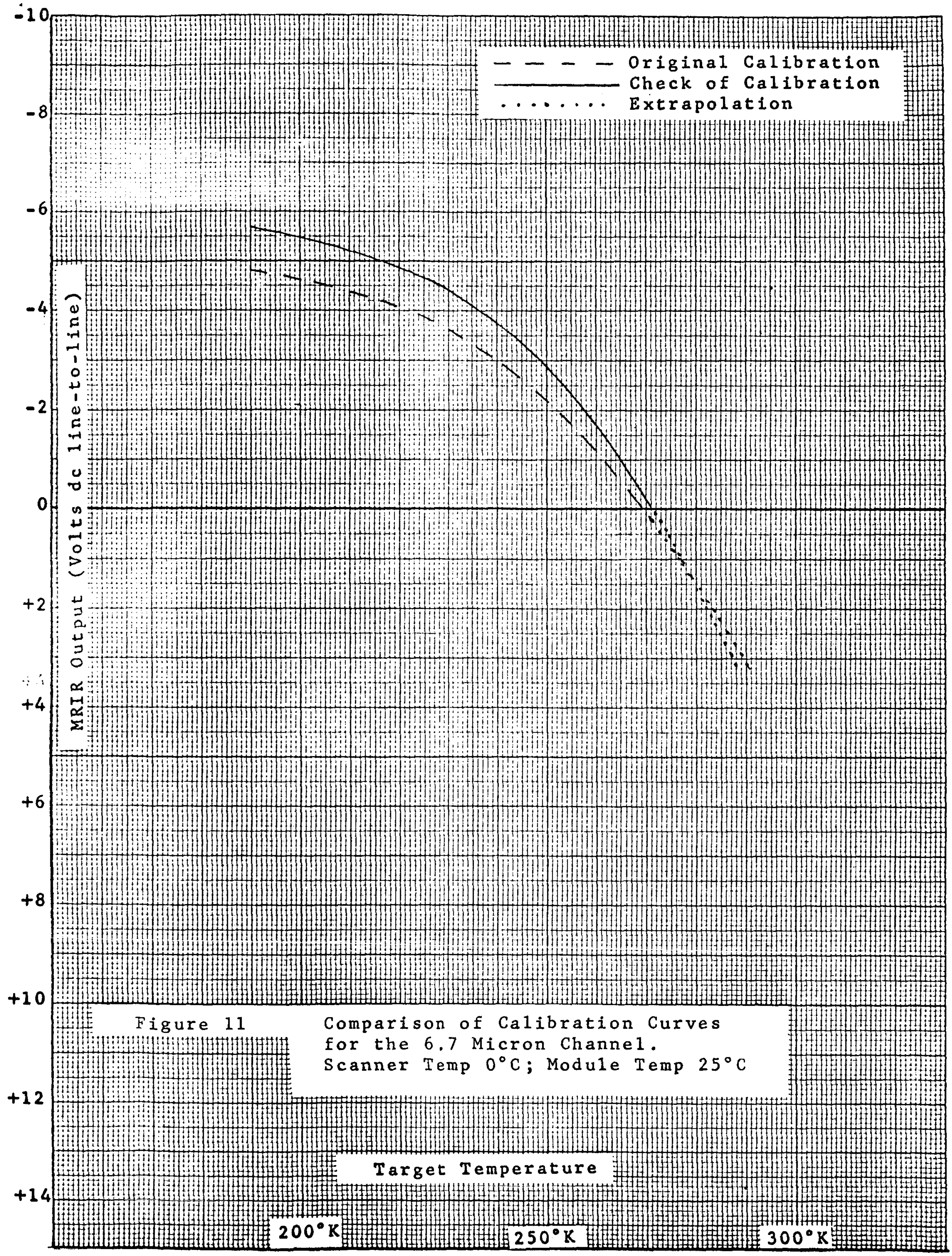

Figure 11 Comparison of Calibration Curves for the 6.7 Micron Channel. Scanner Temp 0°C; Module Temp 25°C

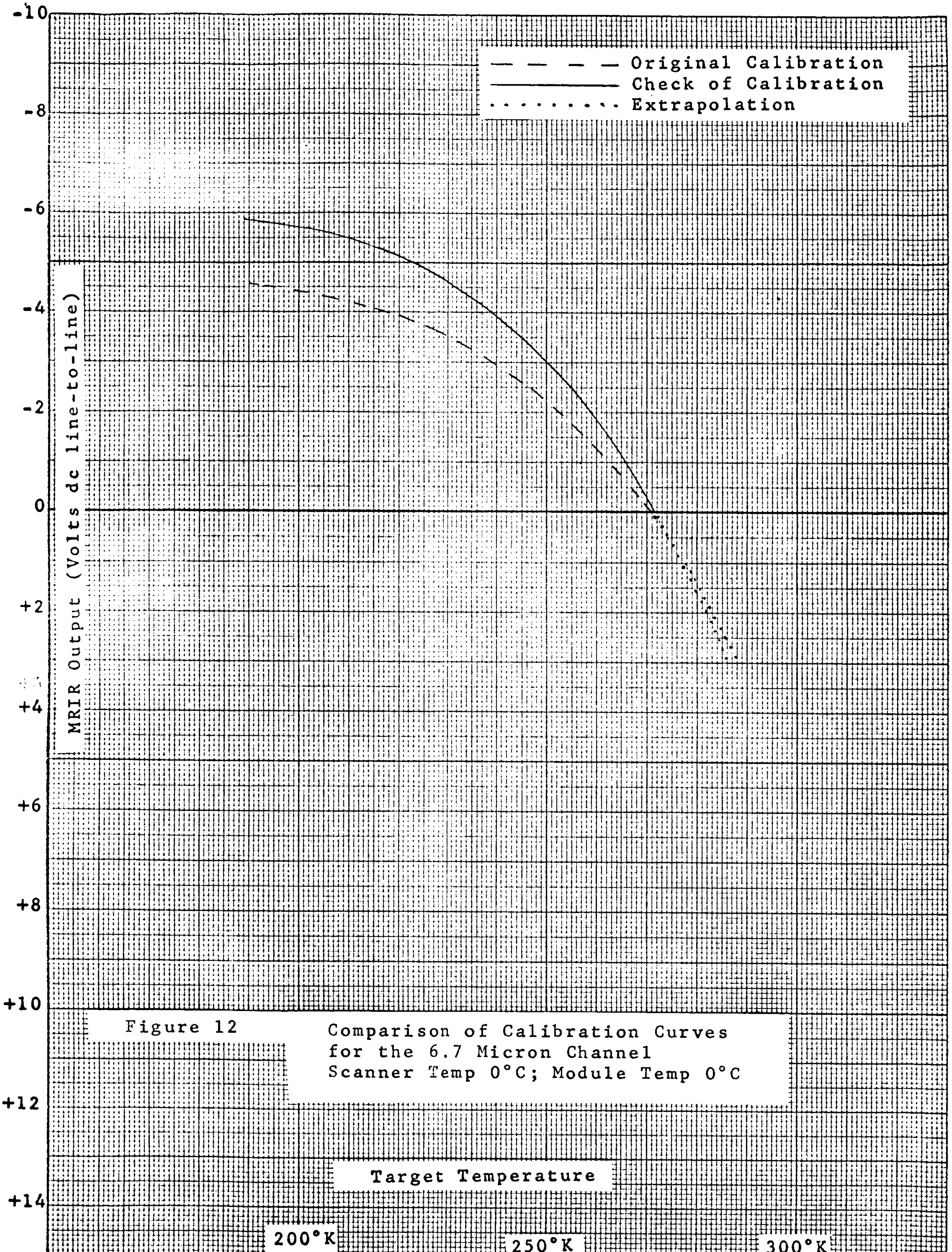

Figure 12 Comparison of Calibration Curves for the 6.7 Micron Channel Scanner Temp 0°C; Module Temp 0°C

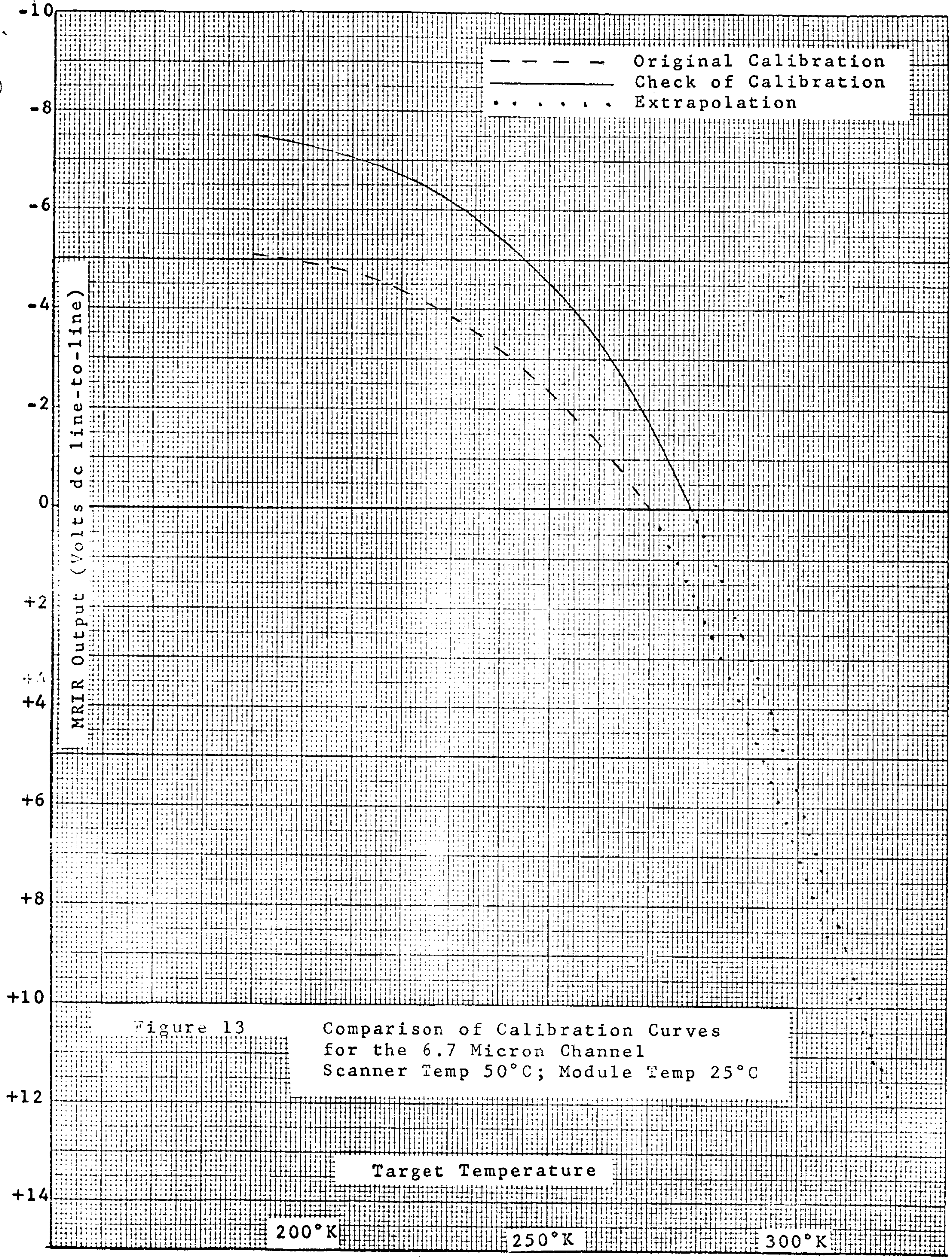

Figure 13 Comparison of Calibration Curves for the 6.7 Micron Channel Scanner Temp 50°C; Module Temp 25°C

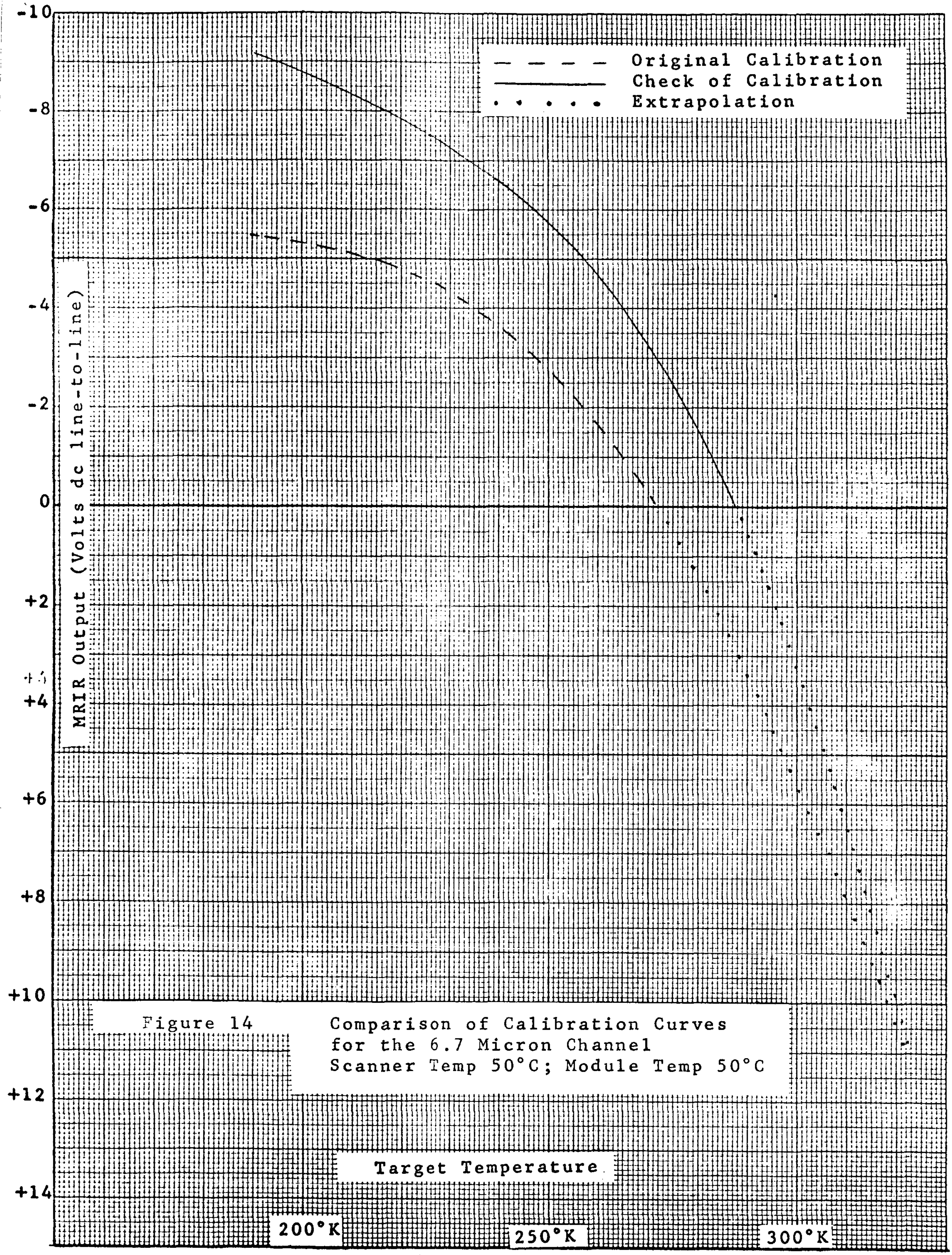

Figure 14 Comparison of Calibration Curves for the 6.7 Micron Channel Scanner Temp 50°C; Module Temp 50°C

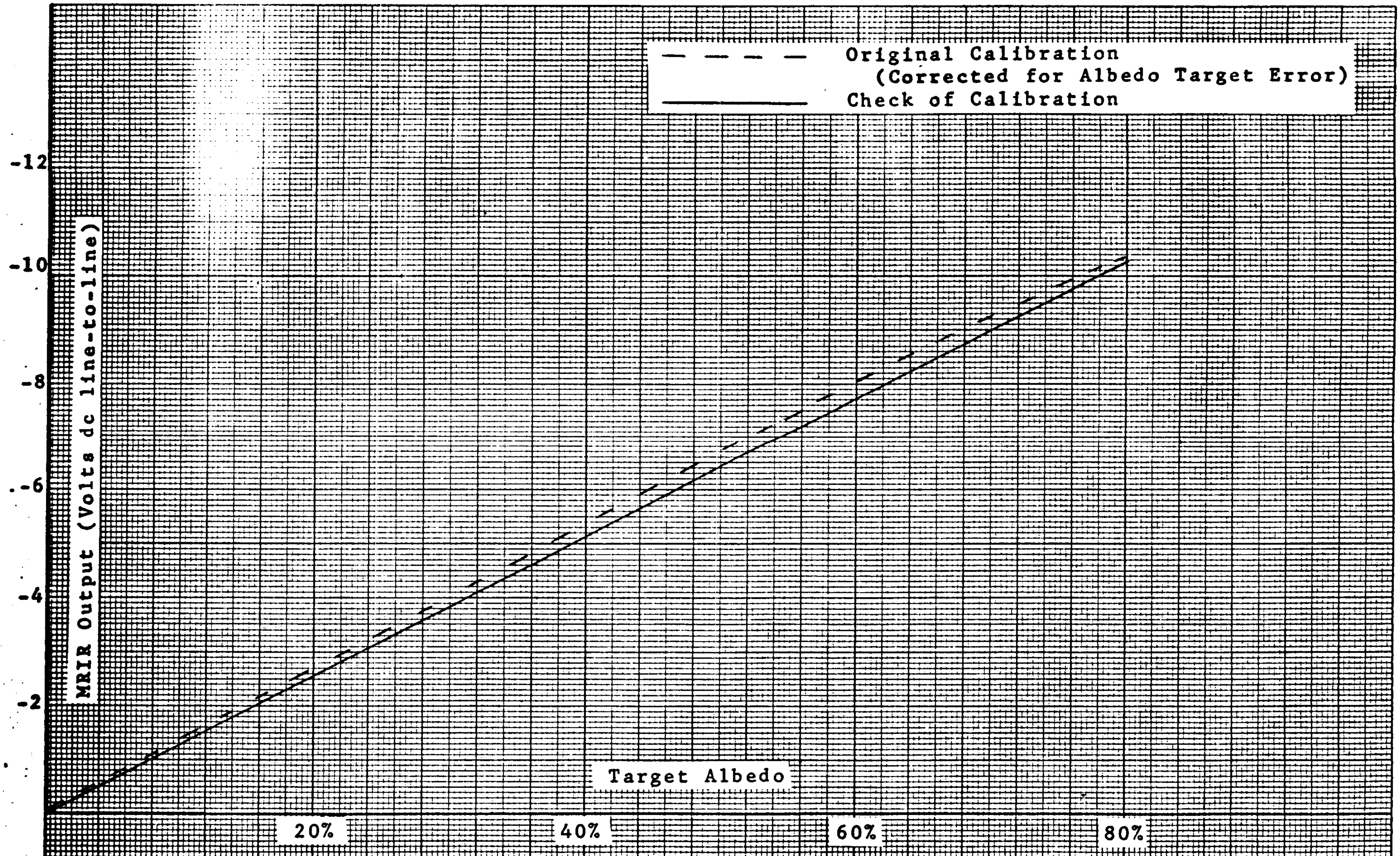

Figure 15 Comparison of Calibration Curves for the 0.2- to 4.0-Micron Channel
Scanner Temperature 50°C; Module Temperature 25°C

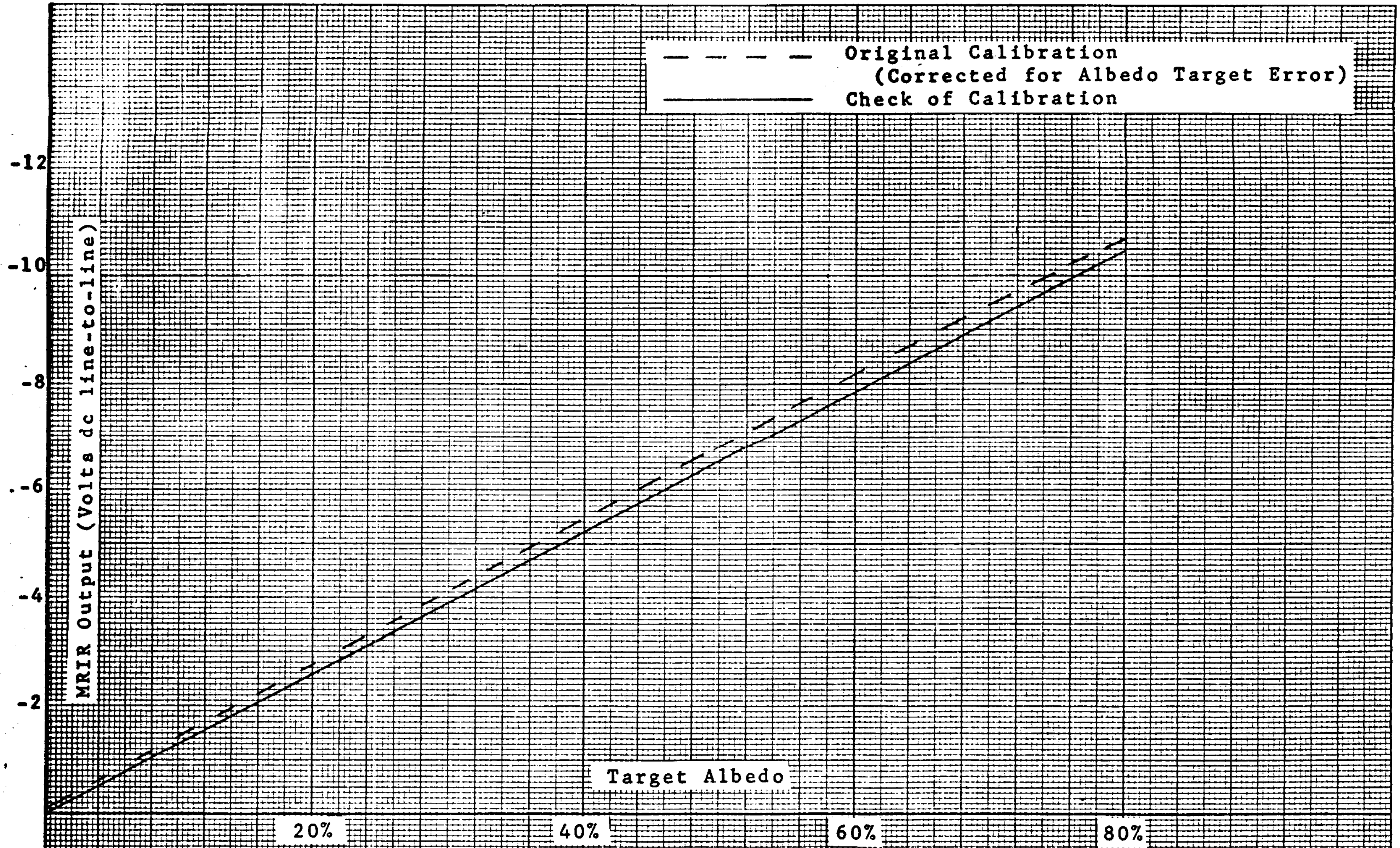

Figure 16 Comparison of Calibration Curves for the 0.2- to 4.0-Micron Channel
Scanner Temperature 50°C; Module Temperature 50°C

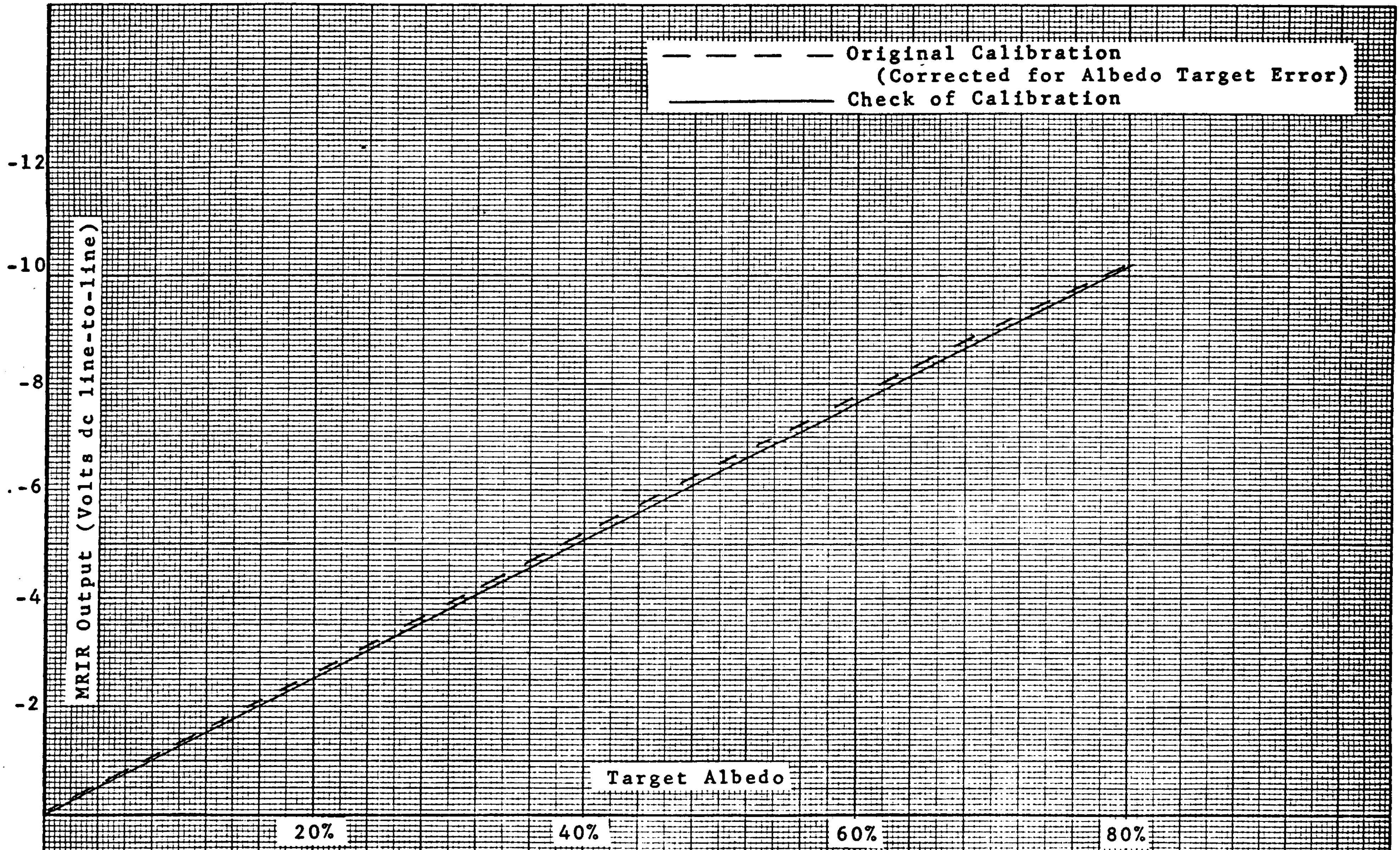

Figure 17 Comparison of Calibration Curves for the 0.2- to 4.0-Micron Channel
Scanner Temperature 0°C; Module Temperature 25°C

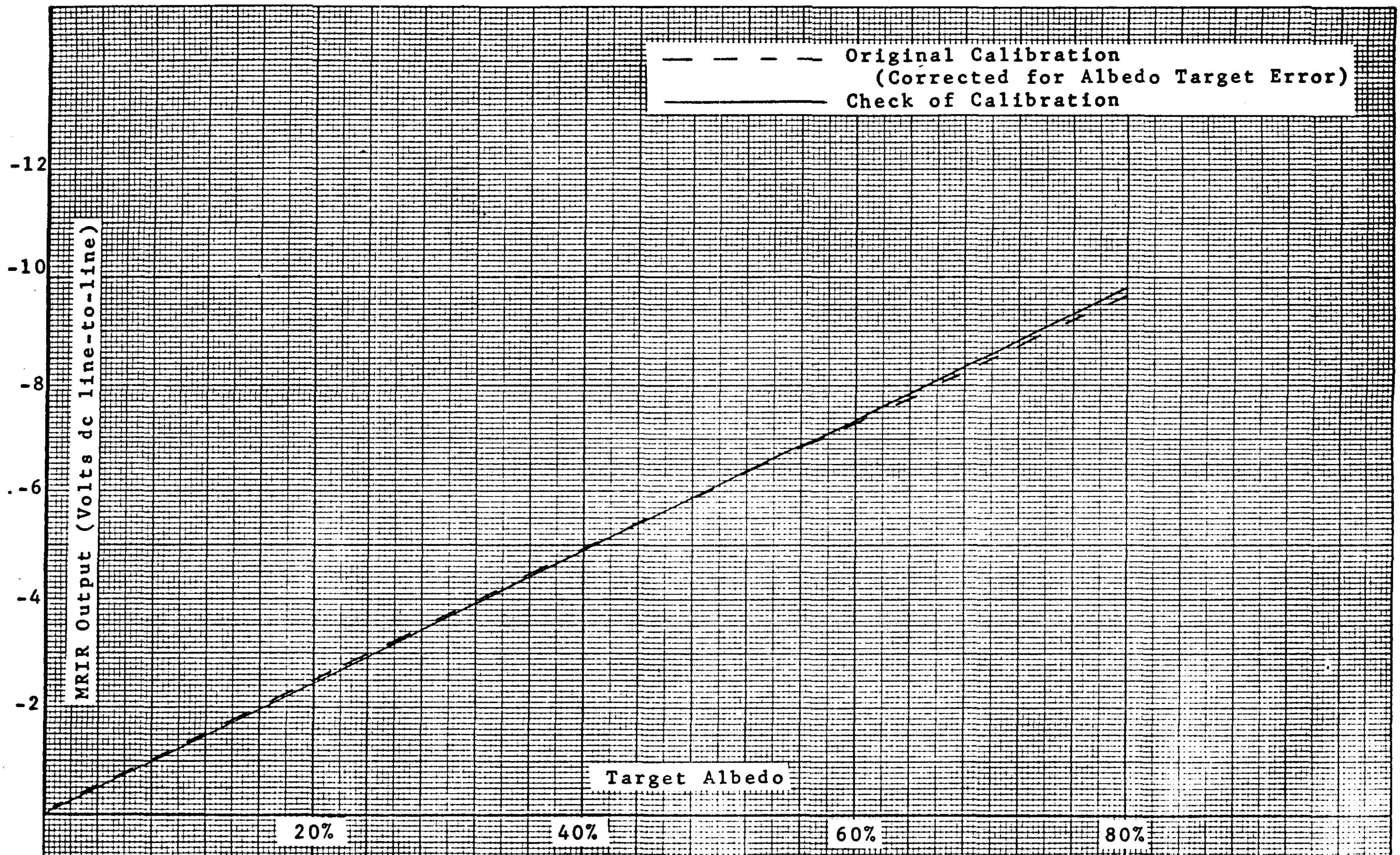

Figure 18 Comparison of Calibration Curves for the 0.2- to 4.0-Micron Channel
Scanner Temperature 0°C; Module Temperature 0°C

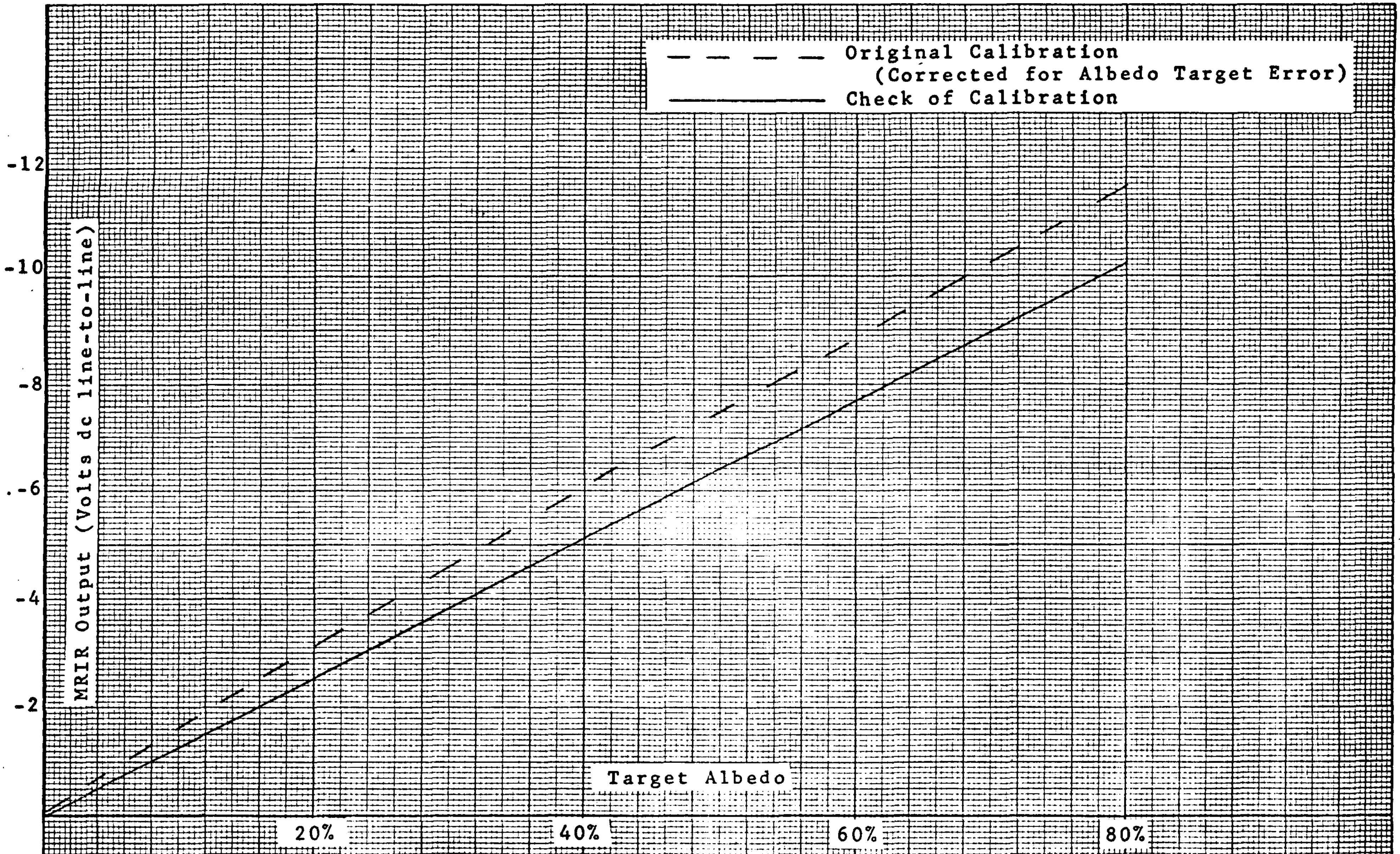

Figure 19 Comparison of Calibration Curves for the 0.55- to 0.85-Micron Channel
Scanner Temperature 50°C; Module Temperature 25°C

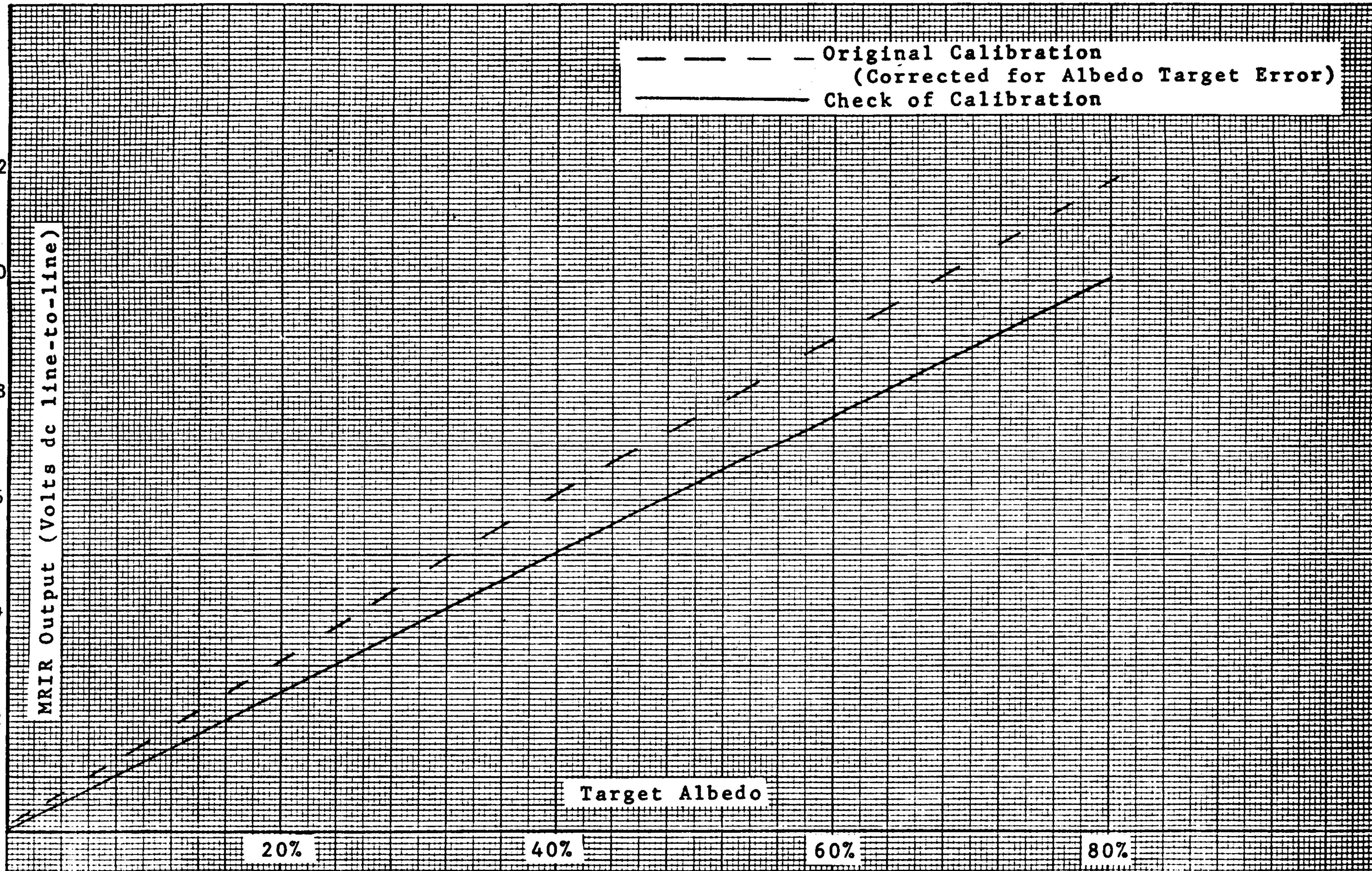

Figure 20 Comparison of Calibration Curves for the 0.55- to 0.85-Micron Channel
Scanner Temperature 50°C; Module Temperature 50°C

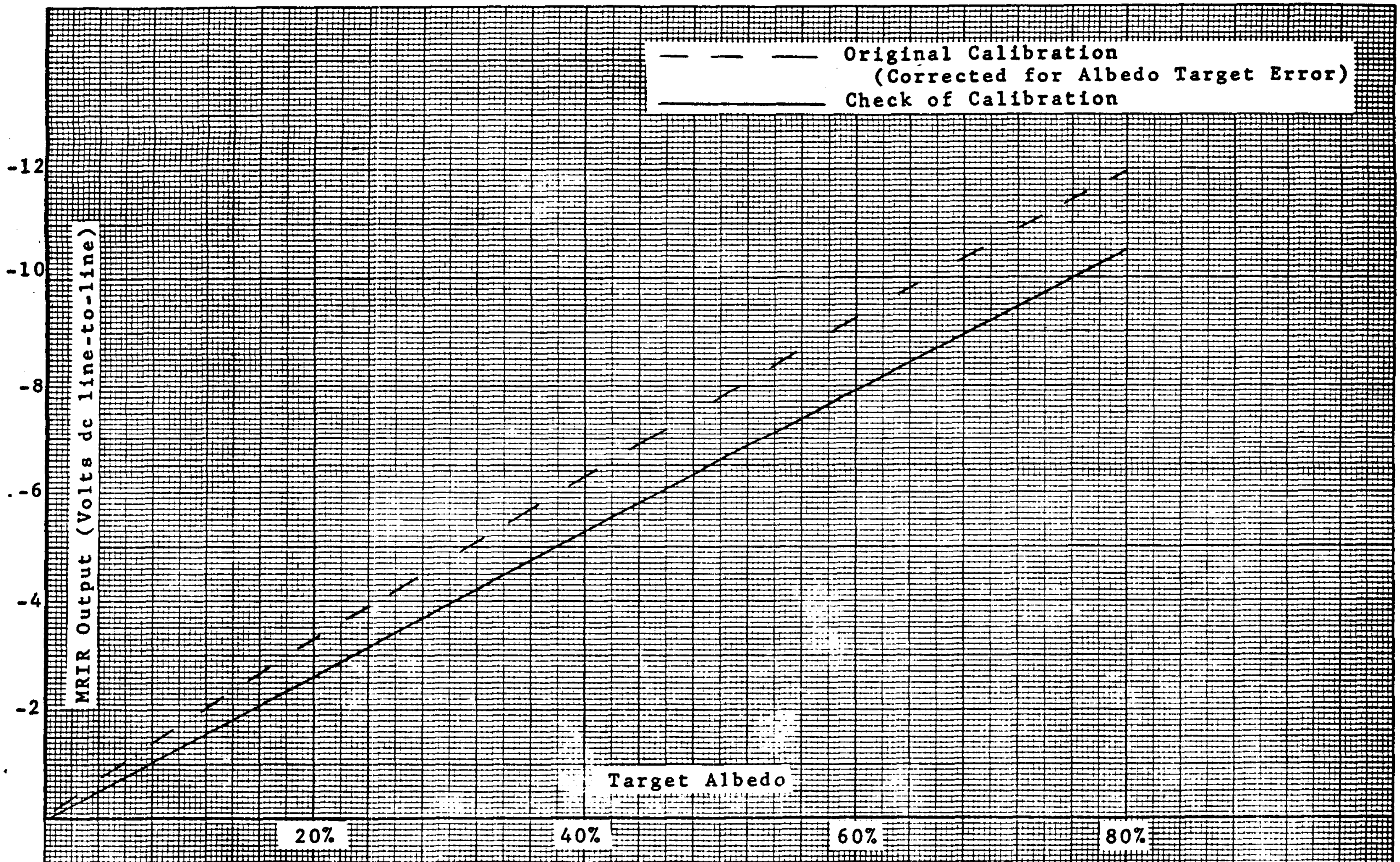

Figure 21 Comparison of Calibration Curves for the 0.55- to 0.85-Micron Channel
Scanner Temperature 0°C; Module Temperature 25°C

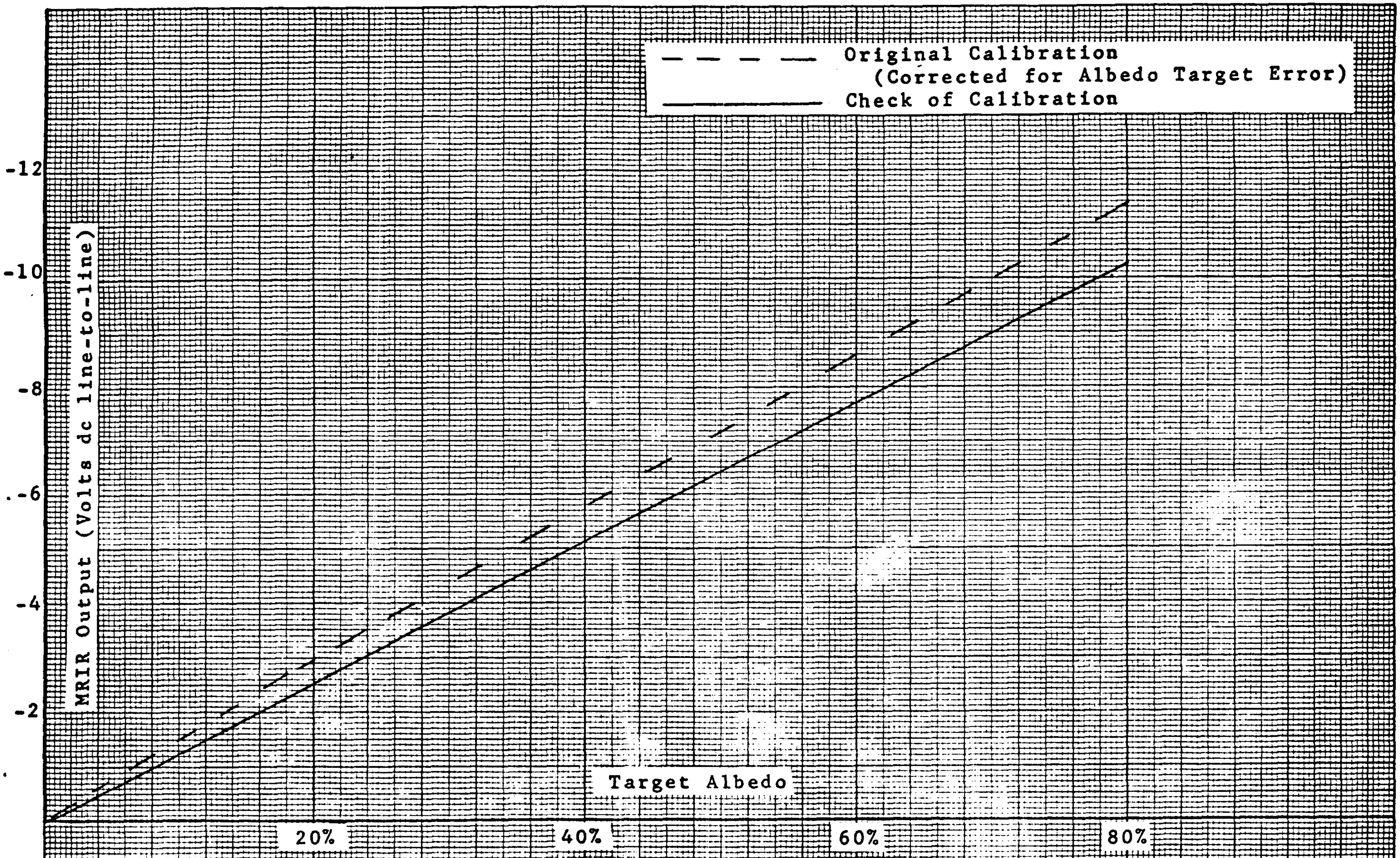

Figure 22 Comparison of Calibration Curves for the 0.55- to 0.85-Micron Channel
Scanner Temperature 0°C; Module Temperature 0°C

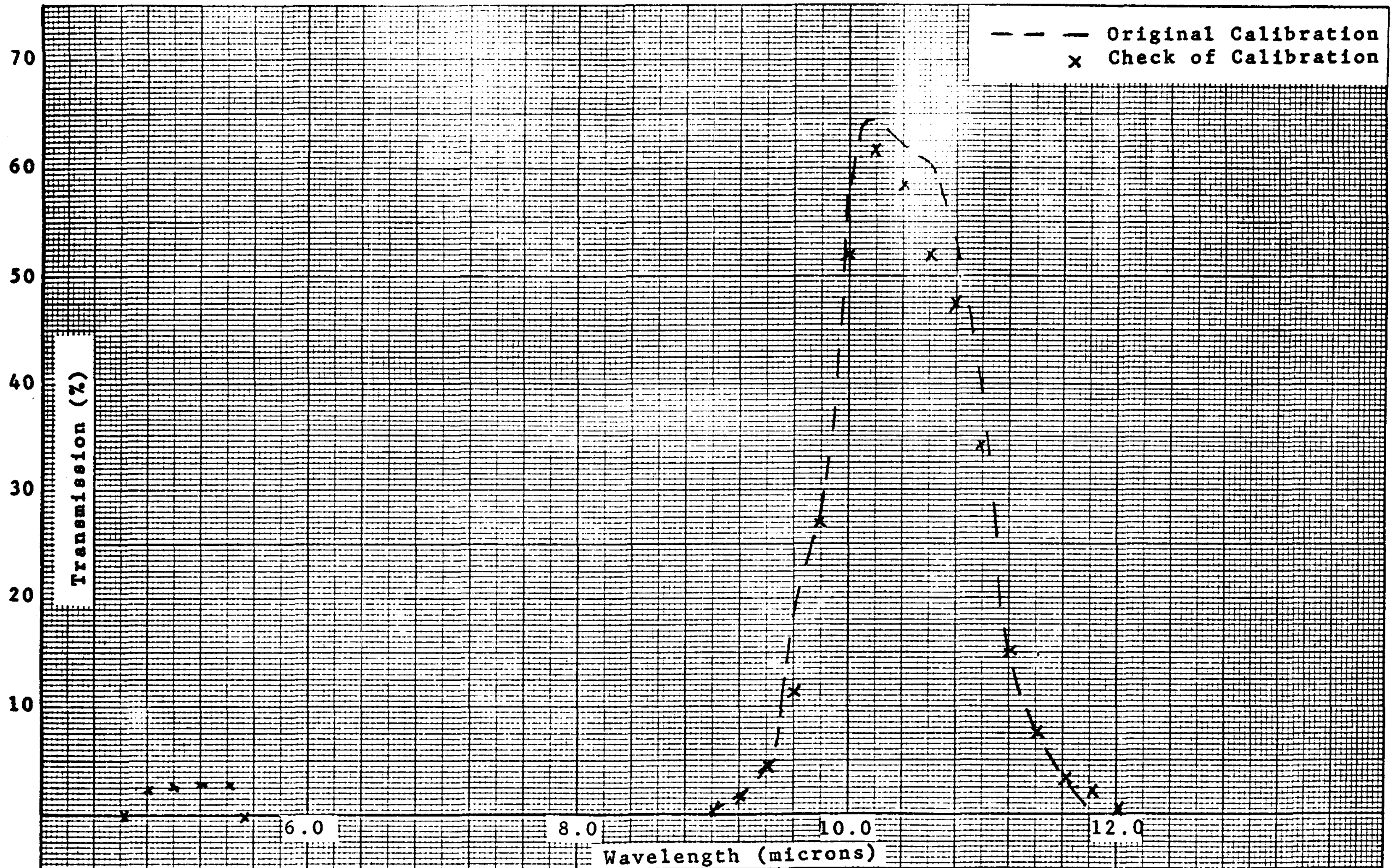

Figure 23 Comparison of Transmission for the 10- to 11-Micron Filter

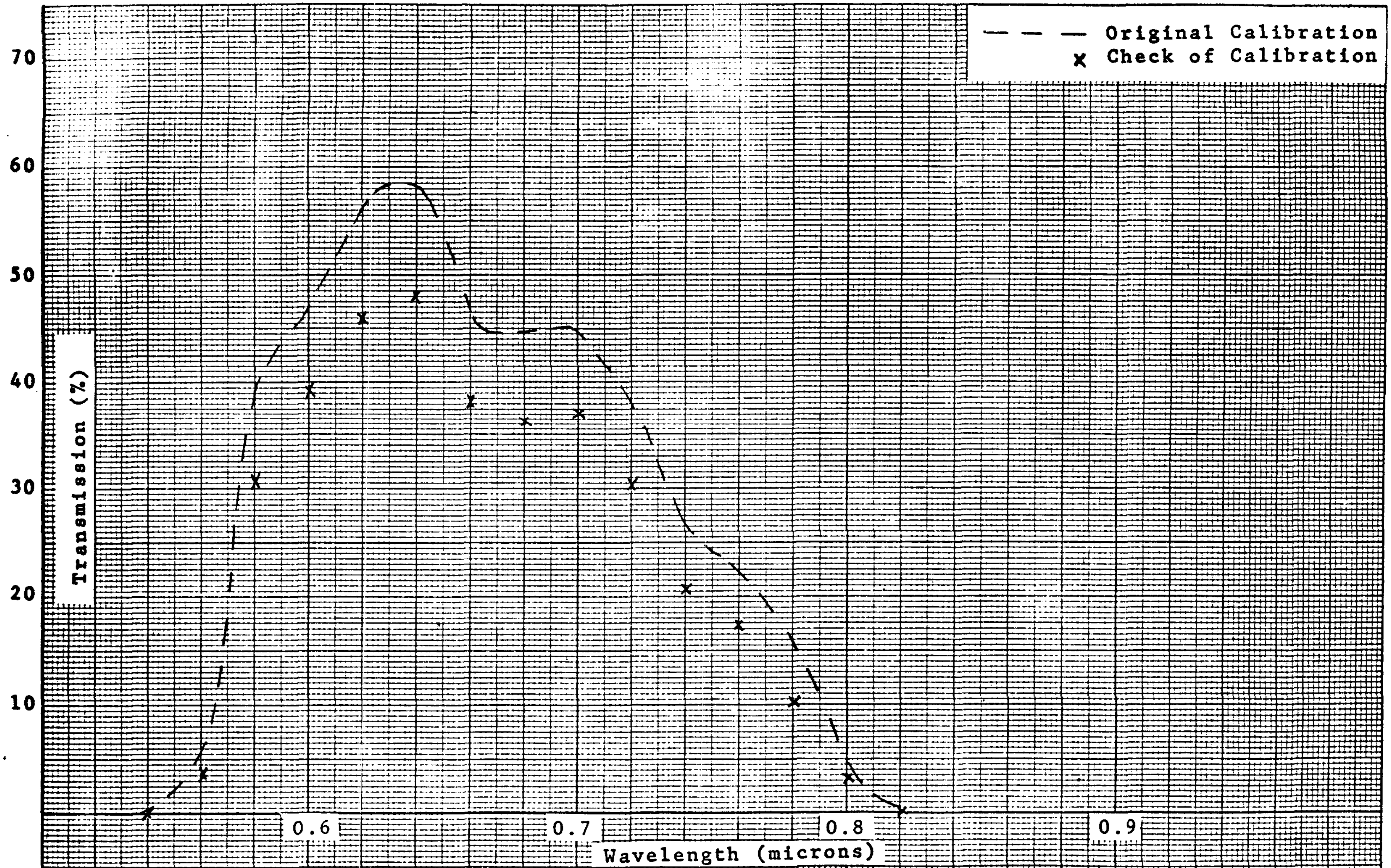

Figure 24 Comparison of Transmission for the 0.55- to 0.85-Micron Filter

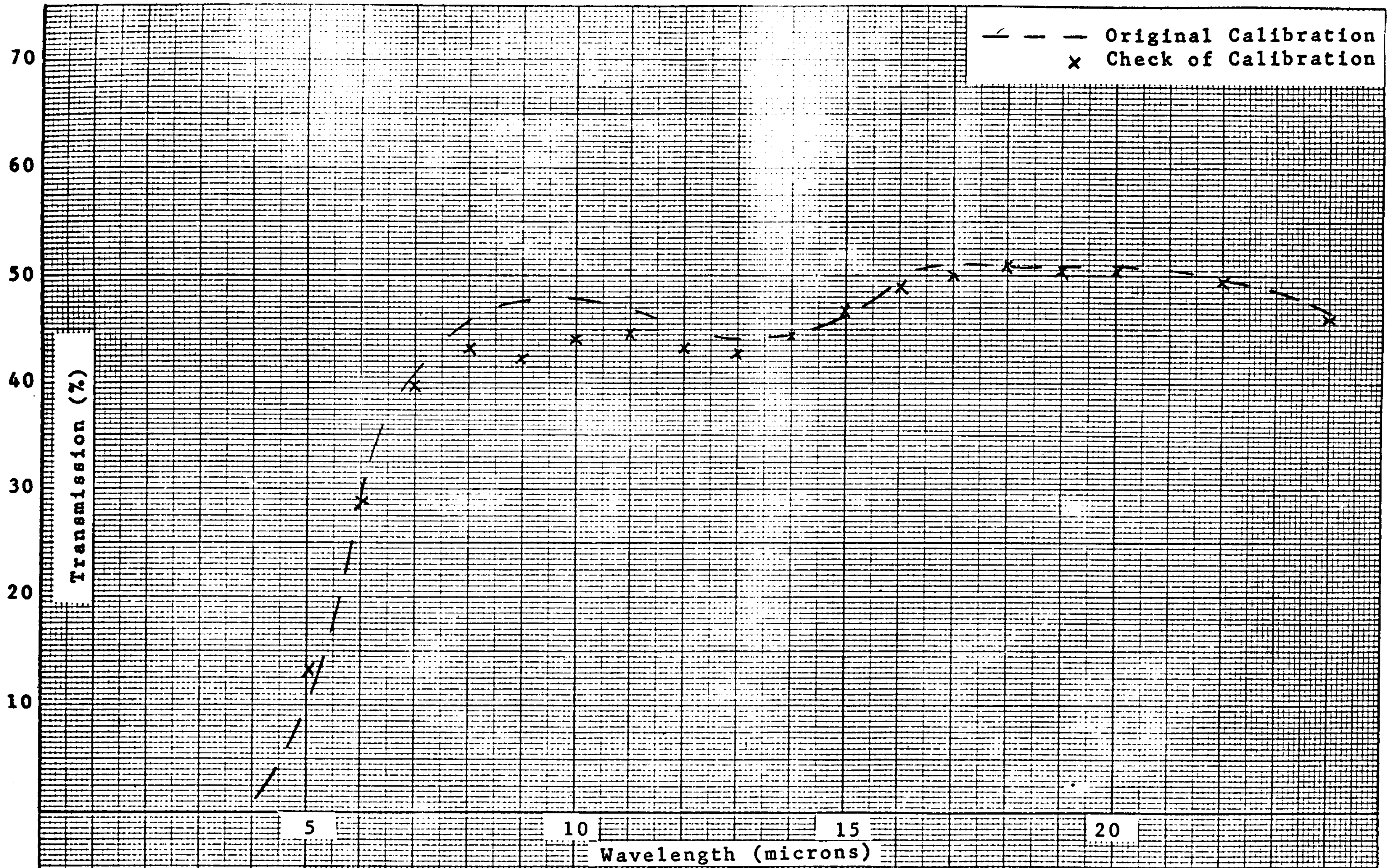

Figure 25 Comparison of Transmission for the 5- to 30-Micron Filter

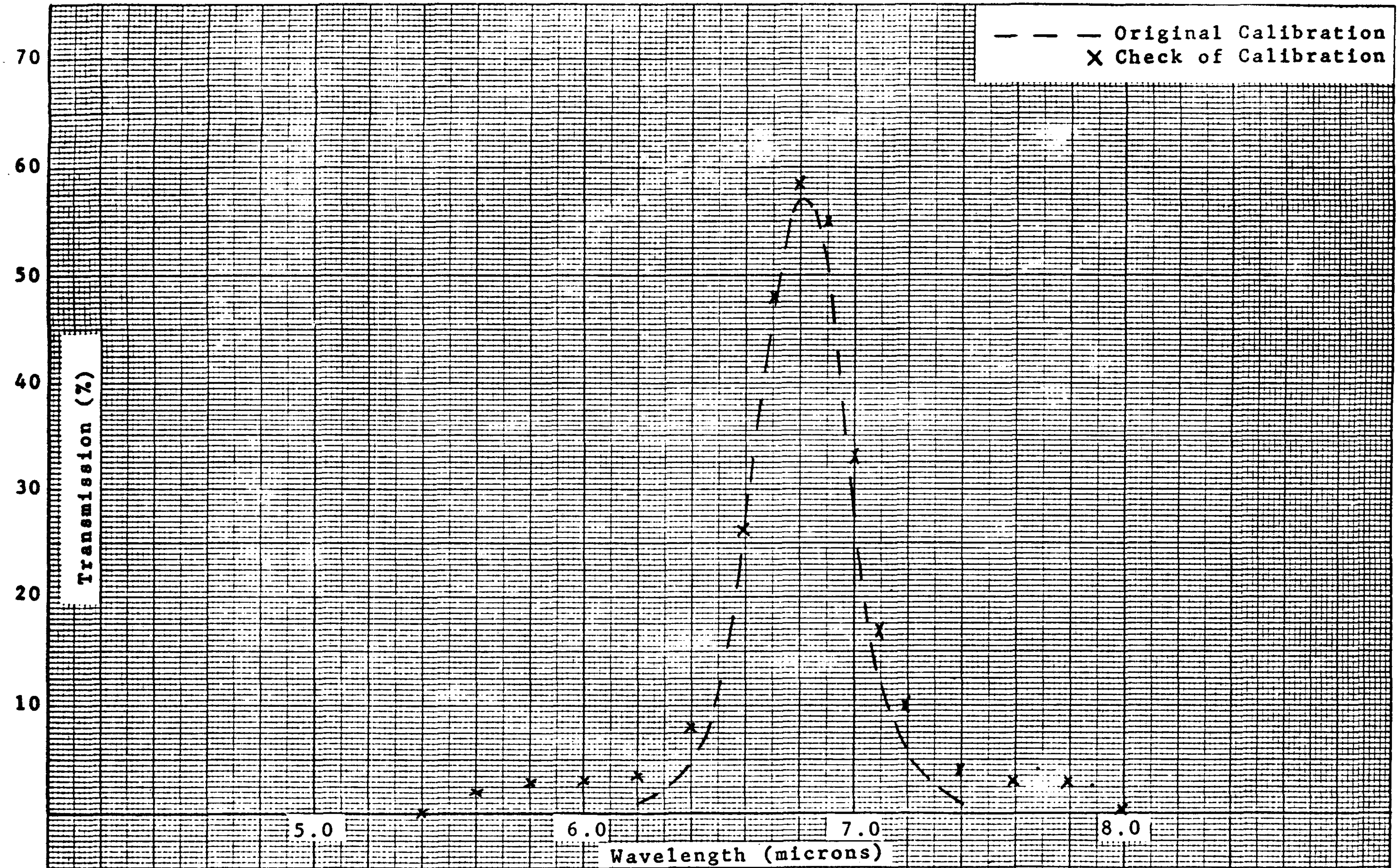

Figure 26 Comparison of Transmission for the 6.7 Micron Filter

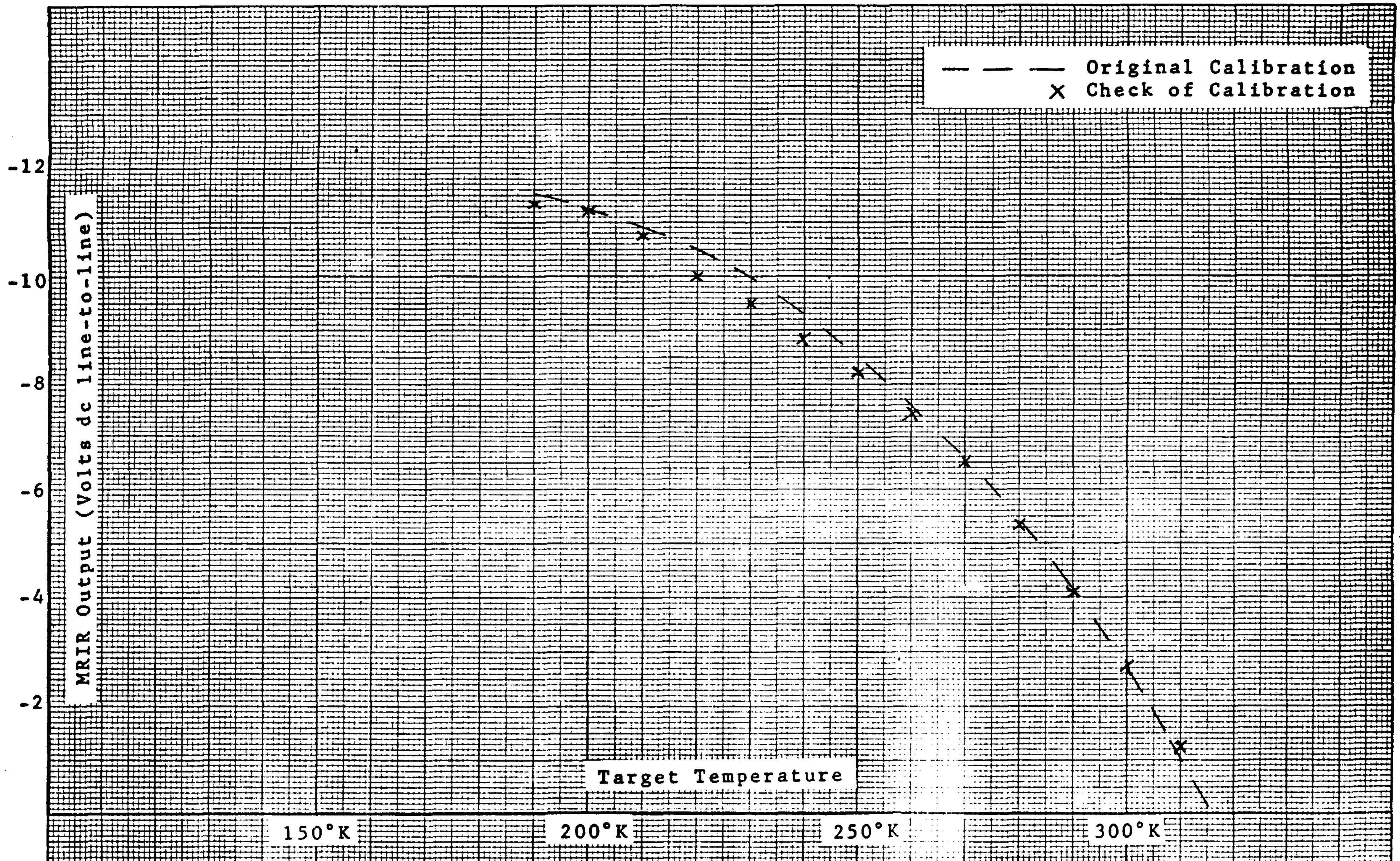

Figure 27 Comparison of Calibration Curves for the 10- to 11-Micron Channel.
Scanner Temperature 25°C; Module Temperature 25°C

Appendix B

CHECK OF CALIBRATION DATA

June 1964

F-1 MRIR
Check of Calibration Data

Module Temperature 25 °C   Scanner Temperature As Indicated

6.7 micron channel

Target Temp	MRIR Temp 50°C	40°C	25°C	10°C	0°C
-93°C	- vdc	- vdc	- vdc	- vdc	- vdc
-83	-7.50	-7.20	-6.50	-5.78	-5.62
-73	-7.45	-7.00	-6.35	-5.65	-5.40
-63	-7.05	-6.70	-6.10	-5.40	-5.25
-53	-6.75	-6.25	-5.70	-5.12	-4.92
-43	-6.25	-	-5.25	-4.68	-4.40
-33	-5.38	-5.10	-4.55	-3.87	-3.80
-23	-4.50	-4.25	-3.95	-3.07	-2.87
-13	-3.37	-3.00	-2.62	-1.87	-1.63
- 3	-1.87	-1.50	-1.10	-0.45	-0.15

10-11 micron channel

Target Temp	MRIR Temp 50°C	40°C	25°C	10°C	0°C
-93°C	- vdc	- vdc	- vdc	- vdc	- vdc
-83	-10.70	-10.05	-9.45	-8.85	-9.25
-73	-10.50	-9.90	-9.20	-8.75	-9.00
-63	-10.20	-9.60	-8.85	-8.50	-8.80
-53	-9.90	-9.25	-8.50	-8.25	-8.60
-43	-9.45	-	-8.10	-8.00	-8.25
-33	-8.80	-8.30	-7.65	-7.60	-7.75
-23	-8.25	-7.75	-7.40	-7.00	-7.25
-13	-7.50	-7.70	-6.50	-6.50	-6.50
- 3	-6.50	-6.25	-5.75	-5.70	-5.75
+ 7	-5.50	-5.10	-4.75	-4.90	-4.75
+17	-4.25	-4.00	-3.85	-3.85	-4.00
+27	-2.75	-2.70	-2.60	-2.75	-2.65
+37	-1.40	-1.25	-1.40	-1.45	-1.30
+47	+0.25	+0.50	+0.40	+0.25	+0.10

June 1964

F-1 MRIR
Check of Calibration Data

Page 2A

Module Temperature 25°C   Scanner Temperature As Indicated

5-30 micron channel

Target Temp	MRIR Temp 50°C	40°C	25°C	10°C	0°C
-93°C	- vdc	- vdc	- vdc	- vdc	- vdc
-83	-10.35	-10.5	-10.7	-10.55	-10.5
-73	-10.00	-10.2	-10.35	-10.25	-10.15
-63	-9.65	-9.75	-9.95	-9.8	-9.7
-53	-9.05	-9.25	-9.50	-9.4	-9.25
-43	-8.55	-	-9.00	-8.78	-8.65
-33	-7.90	-8.00	-8.25	-8.20	-8.10
-23	-7.15	-7.35	-7.60	-7.50	-7.32
-13	-6.40	-6.50	-6.75	-6.75	-6.50
- 3	-5.50	-5.60	-5.90	-5.80	-5.65
+ 7	-4.50	-4.50	-4.85	-4.85	-4.65
+17	-3.25	-3.35	-3.75	-3.75	-3.55
+27	-2.00	-2.00	-2.50	-2.55	-2.35
+37	-0.75	-0.75	-1.20	-1.25	-1.00
+42	-0.00	-0.00	-0.50	-0.50	-0.45

June 1964

F-1 MRIR
Check of Calibration Data

Page 3A

Module Temperature 25°C   Scanner Temperature As Indicated

0.55-0.85 micron channel   MRIR Temp

Albedo	50°C	40°C	25°C	10°C	0°C
0%	- vdc	- vdc	- vdc	- vdc	- vdc
10	-1.35	-1.30	-1.35	-1.35	-1.25
20	-2.50	-2.50	-2.60	-2.50	-2.60
30	-3.85	-3.85	-3.90	-3.80	-4.00
40	-5.15	-5.20	-5.25	-5.15	-5.25
50	-6.40	-6.50	-6.50	-6.35	-6.50
60	-7.70	-7.75	-7.75	-7.75	-8.00
70	-9.00	-9.10	-9.00	-9.0	-9.25
80	-10.25	-10.35	-10.4	-10.4	-10.5
90	-	-	-	-	-
100	-	-	-	-	-

0.2-4 micron channel   MRIR Temp

Albedo	50°C	40°C	25°C	10°C	0°C
0%	- vdc	- vdc	- vdc	- vdc	- vdc
10	-1.25	-1.25	-1.25	-1.25	-1.20
20	-2.55	-2.50	-2.60	-2.55	-2.50
30	-3.80	-3.80	-3.85	-3.75	-3.75
40	-5.05	-5.10	-5.10	-5.00	-5.00
50	-6.35	-6.40	-6.40	-6.30	-6.30
60	-7.65	-7.70	-7.70	-7.55	-7.60
70	-9.00	-9.05	-9.00	-8.95	-8.90
80	-10.25	-10.3	-10.30	-10.2	-10.15
90	-	-	-	-	-
100	-	-	-	-	-

June 1964

F-1 MRIR
Check of Calibration Data

Page 1B

Module Temperature As Indicated   Scanner Temperature As Indicated

6.7 micron channel

Target Temp	MRIR Temp 50°C	40°C	25°C	10°C	0°C
-93°C	- ____ vdc	- ____ vdc	- ____ vdc	- ____ vdc	- ____ vdc
-83	-9.00	-8.00	-7.20	-5.82	-5.87
-73	-8.90	-7.90	-7.00	-5.70	-5.75
-63	-8.50	-7.60	-6.75	-5.45	-5.50
-53	-8.00	-7.30	-6.35	-5.12	-5.13
-43	-7.35	-6.75	-5.75	-4.65	-4.62
-33	-6.60	-6.00	-4.95	-4.12	-3.90
-23	-5.75	-5.00	-3.90	-3.20	-3.00
-13	-4.70	-3.45	-2.62	-2.05	-1.85
- 3	-3.25	-1.85	-1.10	-0.60	-0.25

10-11 micron channel

Target Temp	MRIR Temp 50°C	40°C	25°C	10°C	0°C
-93°C	- ____ vdc	- ____ vdc	- ____ vdc	- ____ vdc	- ____ vdc
-83	-7.85	-7.75	-9.55	-9.75	-10.50
-73	-7.78	-7.60	-9.25	-9.50	-10.45
-63	-7.68	-7.25	-9.00	-9.10	-10.10
-53	-7.55	-7.00	-8.55	-8.75	-9.75
-43	-7.45	-6.75	-8.20	-8.90	-9.25
-33	-7.60	-6.50	-7.70	-8.35	-8.50
-23	-6.75	-6.35	-7.50	-7.75	-8.00
-13	-6.35	-6.20	-7.00	-7.70	-7.10
- 3	-5.90	-5.50	-6.25	-6.25	-6.25
+ 7	-5.25	-4.75	-5.00	-5.25	-5.25
+17	-4.50	-4.00	-3.85	-4.00	-4.20
+27	-3.25	-2.75	-2.75	-2.80	-2.80
+37	-2.00	-1.30	-1.30	-1.40	-1.75
+47	-0.18	+0.30	+0.25	-0.15	-0.00

June 1964

F-1 MRIR
Check of Calibration Data

Page 2 B

Module Temperature As Indicated Scanner Temperature As Indicated

5-30 micron channel

Target Temp	MRIR Temp 50°C	40°C	25°C	10°C	0°C
-93°C	- ______ vdc	- ______ vdc	- ______ vdc	- ______ vdc	- ______ vdc
-83	-10.70	-10.55	-10.75	-10.55	-10.25
-73	-10.40	-10.25	-10.50	-10.25	-10.00
-63	-9.90	-9.85	-10.00	-9.85	-9.50
-53	-9.25	-9.40	-9.50	-9.40	-9.15
-43	-8.55	-8.85	-9.00	-8.75	-8.60
-33	-7.85	-8.20	-8.25	-8.25	-8.00
-23	-7.20	-7.48	-7.50	-7.50	-7.25
-13	-6.50	-6.50	-6.75	-6.75	-6.50
- 3	-5.65	-5.50	-5.85	-5.85	-5.60
+ 7	-4.70	-4.50	-4.85	-4.90	-4.75
+17	-3.55	-3.35	-3.75	-3.75	-3.70
+27	-2.30	-2.15	-2.50	-2.55	-2.55
+37	-0.98	-0.75	-1.25	-1.30	-1.50
+42	-0.20	-0.05	-0.50	-0.60	-0.55

June 1964

F-1 MRIR
Check of Calibration Data

Module Temperature As Indicated   Scanner Temperature As Indicated

0.55-0.85 micron channel   MRIR Temp

Albedo	50°C	40°C	25°C	10°C	0°C
0%	- vdc	- vdc	- vdc	- vdc	- vdc
10	-1.25	-1.30	-1.30	-1.30	-1.25
20	-2.50	-2.50	-2.50	-2.55	-2.55
30	-3.70	-3.80	-3.85	-3.75	-3.90
40	-5.00	-5.10	-5.20	-5.10	-5.20
50	-6.25	-6.20	-6.45	-6.25	-6.45
60	-7.50	-7.55	-7.75	-7.50	-7.75
70	-8.85	-9.00	-9.10	-9.00	-9.10
80	-9.95	-10.10	-10.45	-10.10	-10.35
90	-	-	-	-	-
100	-	-	-	-	-

0.2-4 micron channel   MRIR Temp

Albedo	50°C	40°C	25°C	10°C	0°C
0%	- vdc	- vdc	- vdc	- vdc	- vdc
10	-1.30	-1.25	-1.25	-1.20	-1.23
20	-2.60	-2.60	-2.55	-2.45	-2.50
30	-3.90	-3.85	-3.85	-3.70	-3.70
40	-5.20	-5.18	-5.10	-4.90	-4.85
50	-6.50	-6.50	-6.45	-6.15	-6.10
60	-7.85	-7.80	-7.75	-7.40	-7.35
70	-9.20	-9.15	-9.10	-8.65	-8.65
80	-10.45	-10.45	-10.40	-9.90	-9.90
90	-	-	-	-	-
100	-	-	-	-	-

August 1964

F-1 MRIR
Check of Calibration Data

Module Temperature 25°C   Scanner Temperature As Indicated

6.7 micron channel — MRIR Temp

Target Temp	50°C	40°C	25°C	10°C	0°C
-93°C	- vdc	- vdc	- vdc	- vdc	- vdc
-83	-	-6.95	-6.75	-6.00	-
-73	-	-6.80	-6.60	-5.75	-
-63	-	-6.55	-6.35	-5.40	-
-53	-	-6.20	-5.85	-5.25	-
-43	-	-5.70	-5.35	-4.60	-
-33	-	-5.05	-4.65	-4.05	-
-23	-	-4.20	-3.80	-3.25	-
-13	-	-3.00	-2.62	-2.05	-
- 3	-	-1.60	-1.12	-0.50	-

10-11 micron channel — MRIR Temp

Target Temp	50°C	40°C	25°C	10°C	0°C
-93°C	- vdc	- vdc	- vdc	- vdc	- vdc
-83	-	-10.80	-11.35	-11.4	-
-73	-	-10.60	-11.20	-11.15	-
-63	-	-10.40	-10.75	-10.75	-
-53	-	-9.90	-10.00	-10.40	-
-43	-	-9.50	-9.50	-9.65	-
-33	-	-8.75	-8.85	-9.35	-
-23	-	-8.20	-8.20	-8.50	-
-13	-	-7.25	-7.45	-7.80	-
- 3	-	-6.35	-6.50	-6.60	-
+ 7	-	-5.30	-5.35	-5.60	-
+17	-	-4.20	-4.10	-4.35	-
+27	-	-2.85	-2.75	-3.00	-
+37	-	-1.30	-1.25	-1.50	-
+47	-	+0.25	+0.35	+0.25	-

August 1964

F-1 MRIR
Check of Calibration Data

Page 2C

Module Temperature 25°C   Scanner Temperature As Indicated

5-30 micron channel

Target Temp	MRIR Temp 50°C	40°C	25°C	10°C	0°C
-93°C	- vdc	- vdc	- vdc	- vdc	- vdc
-83	-	-10.4	-10.75	-10.60	-
-73	-	-10.05	-10.40	-10.25	-
-63	-	-9.7	-10.00	-9.75	-
-53	-	-9.15	-9.50	-9.40	-
-43	-	-8.65	-8.95	-8.80	-
-33	-	-8.00	-8.25	-8.25	-
-23	-	-7.25	-7.50	-7.50	-
-13	-	-6.50	-6.75	-6.75	-
- 3	-	-5.50	-5.90	-5.80	-
+ 7	-	-4.60	-4.90	-4.85	-
+17	-	-3.50	-3.75	-3.80	-
+27	-	-2.25	-2.50	-2.60	-
+37	-	-0.95	-1.25	-1.30	-
+42	-	-0.20	-0.50	-0.60	-

Appendix C

INITIAL CALIBRATION DATA

Nov 1962

F-1 MRIR
Initial Calibration Data

Module Temperature 25°C Scanner Temperature As Indicated

6.7 micron channel

Target Temp	MRIR Temp 50°C	40°C	25°C	10°C	0°C
-93°C	- ___ vdc	- ___ vdc	- ___ vdc	- ___ vdc	- ___ vdc
-83	-5.1	-5.0	-4.9	-4.75	-4.8
-73	-4.95	-4.85	-4.7	-4.6	-4.65
-63	-4.75	-4.65	-4.5	-4.35	-4.4
-53	-4.43	-4.35	-4.2	-4.1	-4.1
-43	-3.85	-3.8	-3.75	-3.65	-3.6
-33	-3.2	-3.15	-3.1	-3.05	-3.0
-23	-2.35	-2.37	-2.3	-2.28	-2.15
-13	-1.3	-1.4	-1.35	-1.38	-1.25
- 3	-0.05	-0.1	-0.0	-0.25	+0.1

10-11 micron channel

Target Temp	MRIR Temp 50°C	40°C	25°C	10°C	0°C
-93°C	- ___ vdc	- ___ vdc	- ___ vdc	- ___ vdc	- ___ vdc
-83	-11.8	-11.7	-11.6	-11.15	-11.3
-73	-11.5	-11.4	-11.25	-10.8	-10.9
-63	-11.15	-11.05	-10.9	-10.5	-10.5
-53	-10.75	-10.65	-10.5	-10.1	-10.1
-43	-10.15	-10.1	-10.0	-9.6	-9.5
-33	-9.5	-9.5	-9.3	-9.0	-8.85
-23	-8.75	-8.7	-8.5	-8.25	-8.1
-13	-7.8	-7.8	-7.7	-7.5	-7.4
- 3	-6.8	-6.75	-6.6	-6.5	-6.2
+ 7	-5.65	-5.55	-5.4	-5.3	-5.25
+17	-4.45	-4.2	-3.9	-4.15	-4.1
+27	-3.2	-2.95	-2.7	-2.8	-2.7
+37	-1.6	-1.2	-1.1	-1.2	-1.3
+47	-0.25	+0.25	+0.35	+0.1	-0.2

Nov 1962

F-1 MRIR
Initial Calibration Data

Page 2 D

Module Temperature 25 °C   Scanner Temperature As Indicated

5-30 micron channel   MRIR Temp

Target Temp	50°C	40°C	25°C	10°C	0°C
-93°C	- vdc	- vdc	- vdc	- vdc	- vdc
-83	-11.0	-11.0	-10.9	-10.8	-10.8
-73	-10.65	-10.7	-10.6	-10.5	-10.4
-63	-10.2	-10.25	-10.2	-10.1	-9.9
-53	-9.65	-9.7	-9.7	-9.65	-9.4
-43	-9.0	-8.9	-9.1	-9.05	-8.75
-33	-8.3	-8.3	-8.4	-8.4	-8.0
-23	-7.4	-7.55	-7.65	-7.6	-7.1
-13	-6.5	-6.8	-6.8	-6.85	-6.45
- 3	-5.5	-5.75	-5.8	-5.95	-5.4
+ 7	-4.5	-4.7	-4.8	-4.9	-4.55
+17	-3.5	-3.5	-3.6	-3.75	-3.3
+27	-2.3	-2.25	-2.3	-2.65	-2.4
+37	-0.9	-0.75	-1.0	-1.2	-0.8
+42	-0.2	-0.0	-0.25	-0.4	-0.2

Nov 1962

F-1 MRIR
Initial Calibration Data

Module Temperature 25°C Scanner Temperature As Indicated

0.55-0.85 micron channel * MRIR Temp

Albedo	50°C	40°C	25°C	10°C	0°C
0%	- vdc	- vdc	- vdc	- vdc	- vdc
10	-1.62	-1.62	-1.62	-1.7	-1.7
20	-3.25	-3.25	-3.25	-3.32	-3.32
30	-4.75	-4.75	-4.8	-4.88	-4.8
40	-6.1	-6.1	-6.18	-6.38	-6.38
50	-7.4	-7.4	-7.5	-7.65	-7.65
60	-8.85	-8.85	-9.0	-9.1	-9.25
70	-10.25	-10.25	-10.4	-10.65	-10.8
80	-11.7	-11.7	-11.8	-12.0	-12.0
90	-	-	-	-	-
100	-	-	-	-	-

0.2-4 micron channel * MRIR Temp

Albedo	50°C	40°C	25°C	10°C	0°C
0%	- vdc	- vdc	- vdc	- vdc	- vdc
10	-1.32	-1.32	-1.32	-1.32	-1.26
20	-2.65	-2.65	-2.65	-2.58	-2.58
30	-4.07	-4.12	-4.02	-3.95	-3.85
40	-5.35	-5.35	-5.28	-5.1	-5.17
50	-6.75	-6.75	-6.6	-6.55	-6.55
60	-8.03	-8.03	-7.92	-7.87	-7.8
70	-9.12	-9.12	-9.0	-8.95	-7.9
80	-10.3	-10.35	-10.35	-10.1	-10.2
90	-	-	-	-	-
100	-	-	-	-	-

* Corrected for Albedo Source calibration error found after Calibration

Nov 1962

F-1 MRIR
Initial Calibration Data

Page 1E

Module Temperature As Indicated   Scanner Temperature As Indicated

6.7 micron channel

MRIR Temp

Target Temp	50°C	40°C	25°C	10°C	0°C
-93°C	- vdc	- vdc	- vdc	- vdc	- vdc
-83	-5.4	-5.15	-4.9	-4.62	-4.6
-73	-5.25	-4.95	-4.7	-4.45	-4.4
-63	-5.05	-4.75	-4.5	-4.27	-4.25
-53	-4.85	-4.45	-4.2	-4.0	-3.9
-43	-4.37	-3.95	-3.76	-3.55	-3.5
-33	-3.62	-3.35	-3.1	-3.0	-2.9
-23	-2.75	-2.50	-2.3	-2.25	-2.21
-13	-1.7	-1.50	-1.35	-1.3	-1.4
- 3	-0.37	-0.17	-0.0	-0.1	-0.1

10-11 micron channel

MRIR Temp

Target Temp	50°C	40°C	25°C	10°C	0°C
-93°C	- vdc	- vdc	- vdc	- vdc	- vdc
-83	-12.2	-11.8	-11.6	-10.85	-10.7
-73	-11.9	-11.5	-11.25	-10.6	-10.45
-63	-11.6	-11.15	-10.9	-10.25	-10.2
-53	-11.1	-10.7	-10.5	-9.85	-9.8
-43	-10.5	-10.2	-10.0	-9.35	-9.3
-33	-9.75	-9.5	-9.3	-8.8	-8.7
-23	-9.0	-8.7	-8.5	-8.1	-8.1
-13	-8.2	-7.85	-7.7	-7.25	-7.25
- 3	-7.2	-6.8	-6.6	-6.25	-6.25
+ 7	-6.15	-5.65	-5.4	-5.3	-5.25
+17	-4.7	-4.05	-3.9	-3.9	-3.8
+27	-3.25	-2.8	-2.7	-2.6	-2.6
+37	-1.7	-1.25	-1.1	-1.1	-1.25
+47	-0.1	+0.25	+0.35	+0.35	+0.25

Nov 1962

F-1 MRIR
Initial Calibration Data

Module Temperature As Indicated   Scanner Temperature As Indicated

5-30 micron channel   MRIR Temp

Target Temp	50°C	40°C	25°C	10°C	0°C
-93°C	- vdc	- vdc	- vdc	- vdc	- vdc
-83	-11.4	-11.2	-10.9	-10.55	-10.35
-73	-11.0	-10.8	-10.6	-10.25	-10.0
-63	-10.6	-10.4	-10.2	-9.85	-9.7
-53	-10.0	-9.85	-9.7	-9.35	-9.25
-43	-9.35	-9.25	-9.1	-8.8	-8.7
-33	-8.6	-8.5	-8.4	-8.2	-8.1
-23	-7.85	-7.75	-7.65	-7.5	-7.4
-13	-6.95	-6.9	-6.8	-6.75	-6.7
- 3	-5.95	-5.9	-5.8	-5.75	-5.75
+ 7	-4.85	-4.85	-4.8	-4.8	-4.8
+17	-3.65	-3.6	-3.6	-3.65	-3.75
+27	-2.3	-2.25	-2.3	-2.4	-2.5
+37	-0.85	-0.85	-1.0	-1.1	-1.25
+42	-0.1	-0.1	-0.25	-0.4	-0.45

Nov 1962

F-1 MRIR
Initial Calibration Data

Module Temperature As Indicated   Scanner Temperature As Indicated

0.55-0.85 micron channel *   MRIR Temp

Albedo	50°C	40°C	25°C	10°C	0°C
0%	- vdc	- vdc	- vdc	- vdc	- vdc
10	-1.55	-1.62	-1.62	-1.43	-1.50
20	-3.12	-3.48	-3.25	-3.00	-3.12
30	-4.7	-4.95	-4.8	-4.3	-4.3
40	-6.1	-6.2	-6.2	-5.6	-5.7
50	-7.5	-7.5	-7.5	-7.0	-7.0
60	-9.0	-9.1	-9.0	-8.6	-8.6
70	-10.5	-10.7	-10.4	-9.9	-10.0
80	-12.0	-12.15	-11.8	-11.4	-11.4
90	-	-	-	-	-
100	-	-	-	-	-

0.2-4 micron channel *   MRIR Temp

Albedo	50°C	40°C	25°C	10°C	0°C
0%	- vdc	- vdc	- vdc	- vdc	- vdc
10	-1.37	-1.40	-1.30	-1.25	-1.25
20	-2.75	-2.80	-2.65	-2.50	-2.50
30	-4.10	-4.10	-3.9	-3.8	-3.7
40	-5.5	-5.5	-5.3	-5.05	-4.85
50	-6.8	-6.8	-6.6	-6.27	-6.05
60	-8.2	-8.15	-7.9	-7.45	-7.25
70	-9.45	-9.40	-9.0	-8.65	-8.35
80	-10.7	-10.6	-10.2	-9.8	-9.65
90	-	-	-	-	-
100	-	-	-	-	-

* Corrected for Albedo Source calibration error found after Calibration