

TWENTY-FIRST MONTHLY PROGRESS REPORT

Model 933 Phasolver System

15 May 1965

1. Introduction

This is the twenty-first monthly progress report describing the accomplishments during the month of April, 1965. During this period, the Phasolver system was installed in the test fixture and preliminary testing started. The report details the results of this preliminary testing, provides a summary of the technical accomplishments, and outlines anticipated progress during the month of May, 1965.

2. Survey of Accomplishments

- 2.1 Phase II test fixture checkout was completed and system testing started.
- 2.2 Minor discrepancies of the test fixture were corrected and techniques for measurement were established which minimize thermal expansion effects.
- 2.3 Test 1 of the Phase II testing procedure was completed.
- 2.4 Test 2 of the Phase II testing procedure was started.

3. Results of Testing

3.1 Test 1 - Co/Cu Determination

The capacity measurements were made on the two patterns and the driver disk. It was determined that the new Phasolver pattern (bow-tie) exhibited an unbalance in the capacity measurements while the standard pattern capacity measurements showed all the four quadrant areas to be equal. Compensating capacitors for the bow tie pattern were chosen and incorporated.

3.2 Test 2 - Accuracy, Resolution, and Repeatability

The precision and repeatability of the Phasolver system and the test set was demonstrated during April, 1965. Testing included measurements at integral millimeter settings and within selected pole pairs as outlined in the test procedure. Minor modifications to the test fixture and test procedure were implemented to minimize thermal effects on the measurements due to handling of gage blocks.

Declassification Review by NGA

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Results to date have been extremely encouraging and are summarized as follows:

A. Resolution

The resolution of the Phasolver system is presently limited by the digital counter; resolution of 0.1 micron can be routinely demonstrated. Finer resolution appears possible.

B. Drift

Maximum drift of the digital output of the Phasolver system over extended periods does not exceed 0.3 micron. This has been demonstrated by taking periodic measurements over a 24 hour (overnight) and 48 hour (week-end) period.

C. Test Repeatability

Test repeatability over many repeated settings of the test fixtures is limited by thermal effects due to gage block handling and temperature changes within the test fixture. It has been demonstrated that the test fixture and the measurement techniques can introduce approximately 2 microns variation, due to thermal expansion of the gage blocks. Since this is further complicated by the requirement for "wringing together" of gage blocks, some of the uncontrolled thermal effects were eliminated when measurements were limited to single block increments. Only five blocks are available and, therefore, measurements were repeated at these settings.

Results are shown in the attached curves, representing five sets of measurements on the standard pattern and 13 sets of measurements on the new (bow-tie) pattern. From these curves it can be seen that the maximum deviation is approximately 4.5 microns at 125 mm measurement using the bow-tie pattern. It is significant to note that measurements at 23, 30 and 60 mm demonstrated a repeatability within 1 micron. Therefore, it can be deduced that the measurements at 125 and 250 mm include uncontrolled thermal effects tending to make the measurements more varied. Measurements with the standard pattern, indicating better repeatability, were made over a shorter time frame and represent fewer measurements.

D. Phasolver Precision

Based upon the data taken today, the following can be summarized:

1. Resolution of 0.1 micron can be demonstrated with better resolution possible.

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2. Repeatability is dependent upon the test fixture and at short distances is within 1 micron, at longer distances uncontrolled thermal expansion of the elements of the test fixture introduce larger uncertainties when longer distances are measured. Repeatability errors are due in part to thermal effects in the test fixture.

3. Precision (conformance)

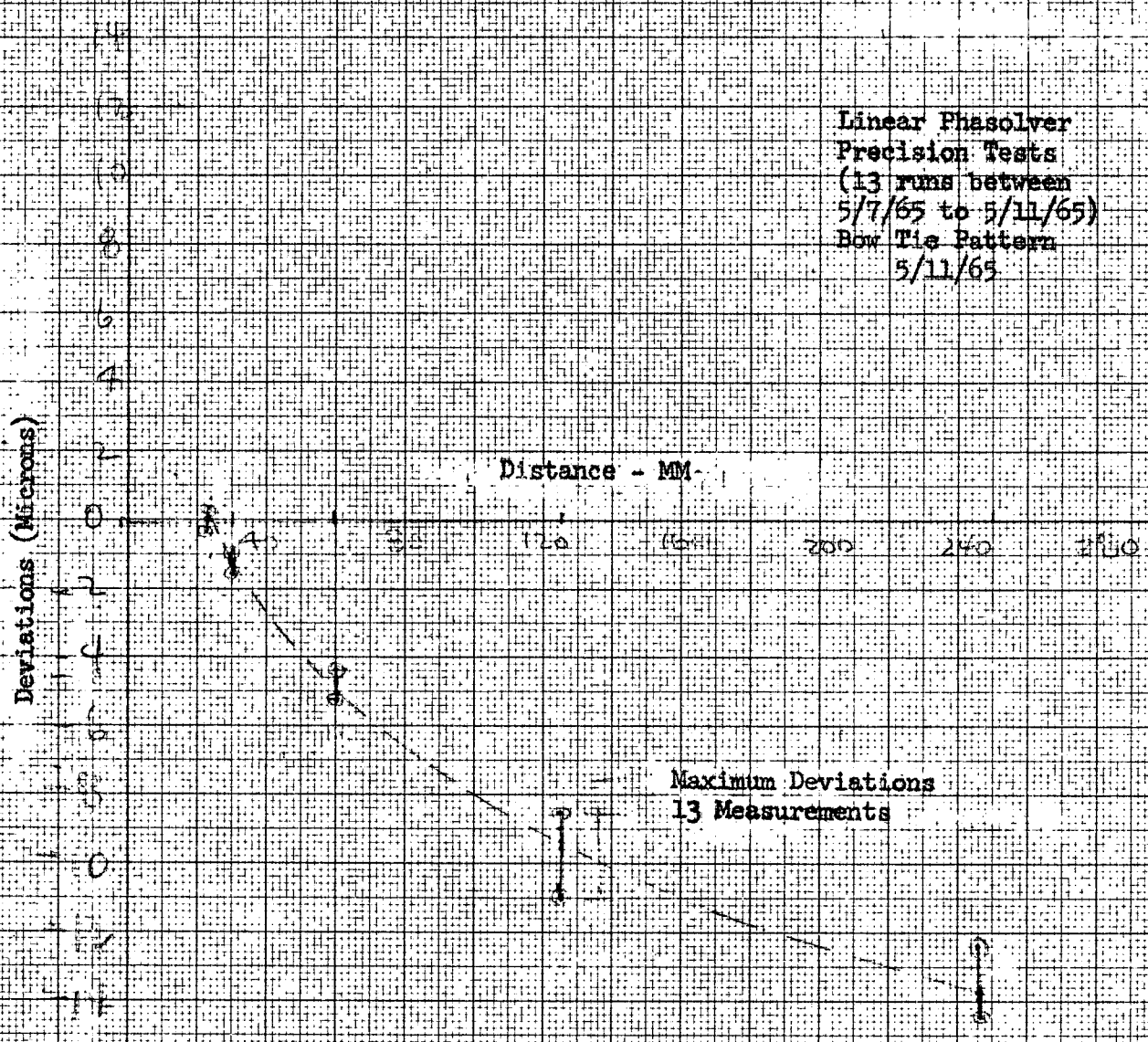
The measurement shows a still unexplained non-linearity of the Phasolver system being tested. This has been hypothesized to be due to some physical deterioration of the test fixture. This non-linearity is however systematic and repeatable, and can be incorporated within the computer program used in conjunction with the measurement engine.

The measurements to date indicate that if the uncontrolled thermal effects can be eliminated, a precision within 1 micron can be attained over the 250 millimeter Phasolver range. The precision at short distances appears to be within  $\pm 1$  micron, including these thermal effects.

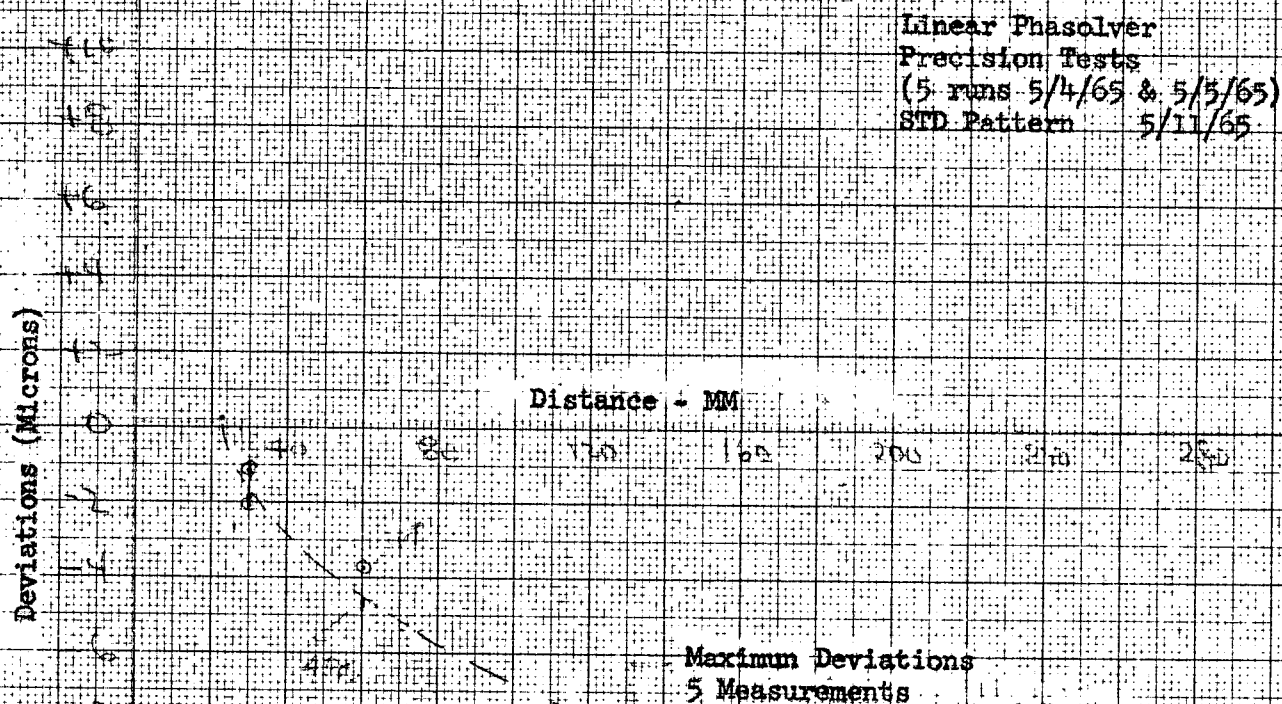
4. Anticipated Progress During May, 1965

4.1 Continue Phase II test program.

4.2 Investigate non-linearity of Phasolver test set.



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PRELIMINARY DATA

(THERMALLY UNCOMPENSATED)

TWENTIETH MONTHLY PROGRESS REPORT

Model 933 Phasolver System

10 April 1965

1. Summary

The following items were accomplished during this period:

1.1 The assembly, wiring and initial electrical checkout of the Phase II system test fixture has been completed.

1.2 The Phase II system test procedure has been generated.

2. Phase II System Tests

The following major test categories have been planned for the Phase II system tests:

2.1 Test 1 - Co/Cv Determination

2.2 Test 2 - Accuracy, Resolution, Test Repeatability

2.3 Test 3 - Pattern Separation

2.4 Test 4 - Driver Coupled Output

2.5 Test 5 - Skew

2.6 Test 6 - Tilt

2.7 Test 7 - Gap

A copy of the Phase II system test procedure is enclosed.

3. Work Planned for the Next Report Period

3.1 Conduct Phase II System Tests

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