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COMPARISON OF THE STI "NIPIP" TRACKING DYNAMICS IDENTIFICATION WITH THE ON-LINE FOURIER ANALYZER "DFA" RESULTS INCLUDING A TIME VARYING CASE

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The Non-Intrusive Pilot Identification Procedure (NIPIP) recently developed at STI and described at the 1981 Annual Manual has been used to identify operators who were compensatory tracking a "sub-critical-instability" task; i.e., the controlled element: $Y_c = K/(s-2)$. NIPIP uses a time domain least squares procedure converting to frequency domain coefficients. The forcing function was a sum of sinusoids supplied by the STI Mark II Describing Function Analyzer, which computes on-line Fourier coefficients of the operator's error/input describing function. The resulting open-loop and operator dynamics computed by each procedure are compared, and they are shown to be reasonably close when there is reasonable power in the error signal at the measurement frequencies.

A special run was made in which the operator abruptly reduced gain within 1 sec, and the ability of the NIPIP to identify this step time variation in the operator is illustrated.

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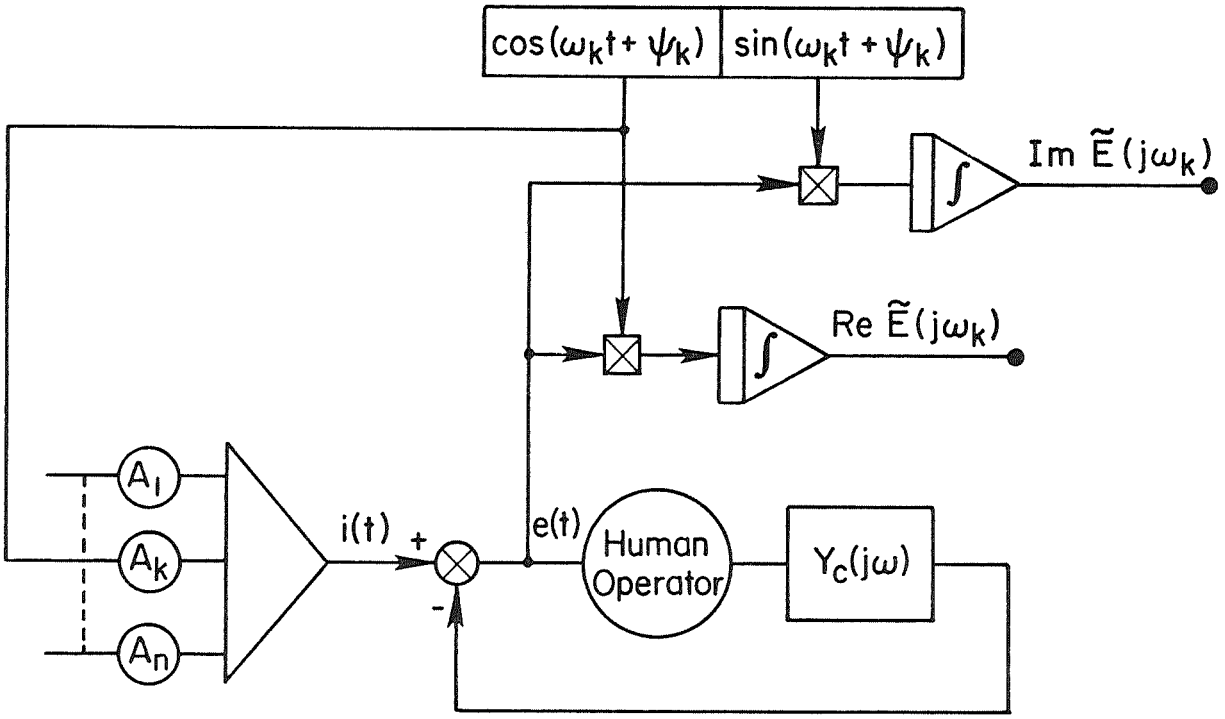
THE DESCRIBING FUNCTION ANALYZER - D.F.A.
SIMPLIFIED FOURIER ANALYSIS



DESCRIBING FUNCTION RELATIONSHIPS

MEASURE

ERROR/INPUT : $$\overrightarrow{Y_{ie}} = \frac{E(j\omega_k)}{I(j\omega_k)} \qquad (1)$$

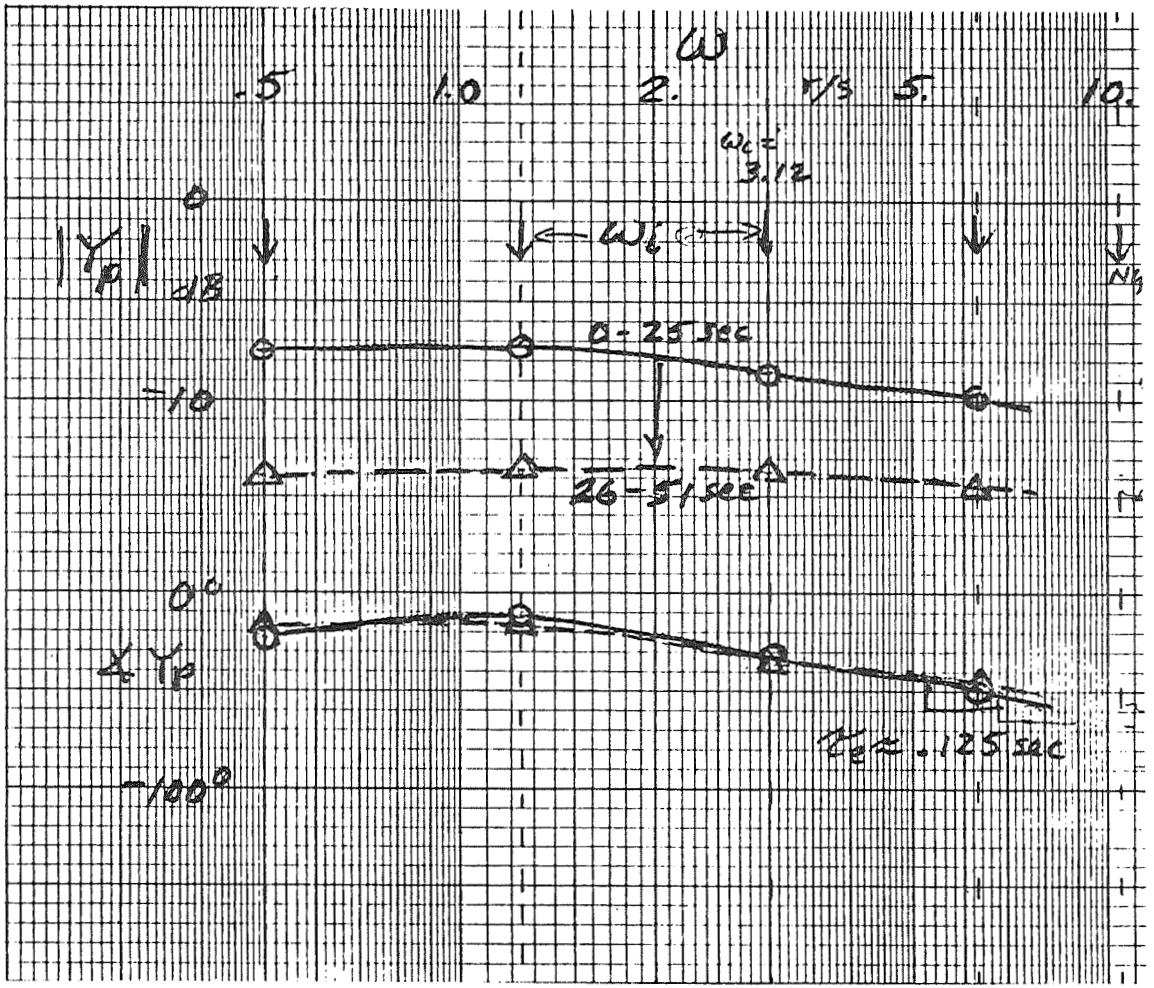
DERIVE

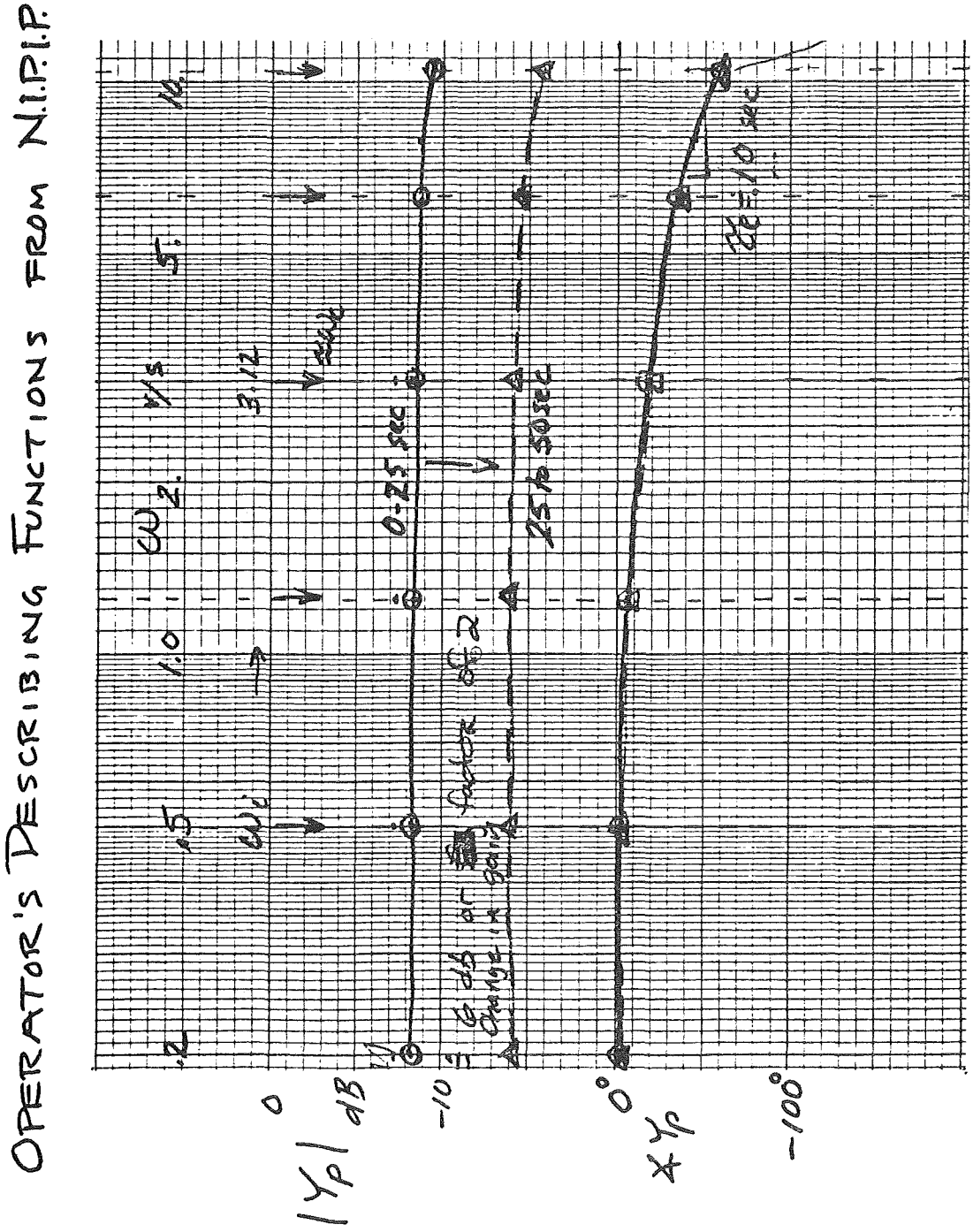
OPEN LOOP : $$\overrightarrow{Y_{OL}} = \frac{1}{\overrightarrow{Y_{ie}}} - 1 \qquad (2)$$

CLOSED LOOP : $$\overrightarrow{Y_{CL}} = 1 - \overrightarrow{Y_{ie}} \qquad (3)$$

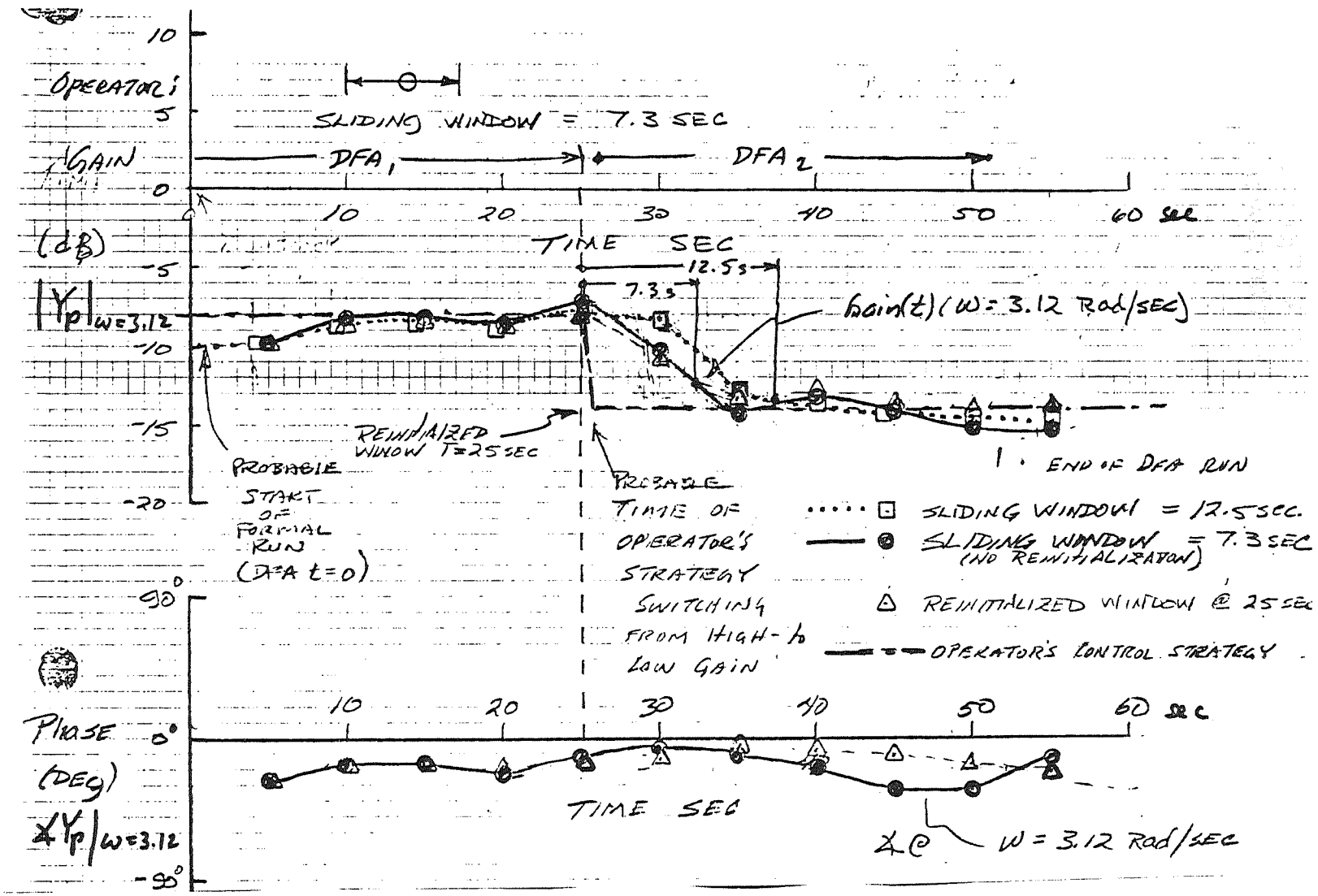
HUMAN OPERATOR: $$\overrightarrow{Y_p} = \frac{\overrightarrow{Y_{OL}}}{\overrightarrow{Y_c}} \qquad (4)$$

OPERATOR'S DESCRIBING FUNCTIONS FROM THE D.F.A.





TIME COURSE OF NIPIP'S Y_p @ ω = 3.12 r/s FOR VARIOUS "WINDOWS"



CONCLUSIONS

- NIPIP RESULTS CLOSELY MATCH DFA FOR FREQUENCIES BELOW GAIN CROSSOVER, WHERE $|E/I\ (j\omega)| < 1.0$

- ABOVE ω_c, IN NOISY CASES (LOW A_i, FATIGUED OPERATOR), DFA DATA ARE UNRELIABLE

- CONVERSION OF TIME DOMAIN COEFFICIENTS TO FREQUENCY DOMAIN DESCRIBING FUNCTIONS AT ω_i's, GIVES VERY RAPID AND ACCURATE DATA

- NIPIP CAN "FOLLOW" TIME A VARYING OPERATOR WITH AN EFFECTIVE LAG $\approx$ SLIDING-WINDOW TIME