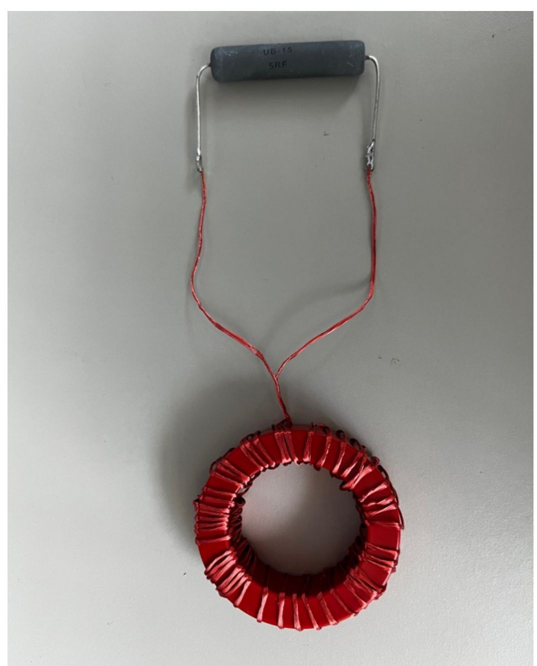
Magnesil Current Transformer Datasheet

Prepared for:	CBMM North America
CBMM	1000 Omega Drive
	Pittsburgh, PA 15205



Description of Device Under Test (DUT).

The current transformer is a measurement device which reduces high voltage currents to a lower value to provide a proper value of measuring current flowing through a current carrying conductor. The output is supplied into a resistive load such that the seconary core will satureate or cause failure into excessive voltage breakdown. Specifically, the current transformer is configured to be a toroidal current transformer, or, the line that has the current flowing is the primary winding, and the voltage is read across the resistor. Compared in performance to other current transformers, this is designed and configured with a Magnesil Core.

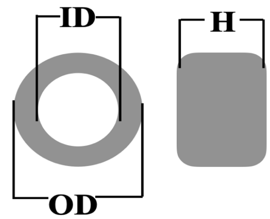
Test Facility	
Test Laboratory	AMPED
Address	1435 Bedford Avenue
City, State, Zip Code	Pittsburgh, PA 15219
Phone	412-802-0988
Fax:	412-802-0779
Website:	www.engineering.pitt.edu/AMPED

Test Personnel	
Name	Chris Bracken
Title	Research Associate
Signature	

Datasheet Revision History			
Revision	**Date**	**Description**	**Revised By**
N / C	Date of Release	Initial Release	CSB (Initials of Revisor)

Core Specifications

Dimensions			
Description	Symbol	Sample Dimension (mm)*	Actual Dimension Used (mm)*
Core Inner Diameter	ID	34.83	38.1
Core Outer Diameter	OD	53.7	50.8
Core Height	H	15.13	12.7



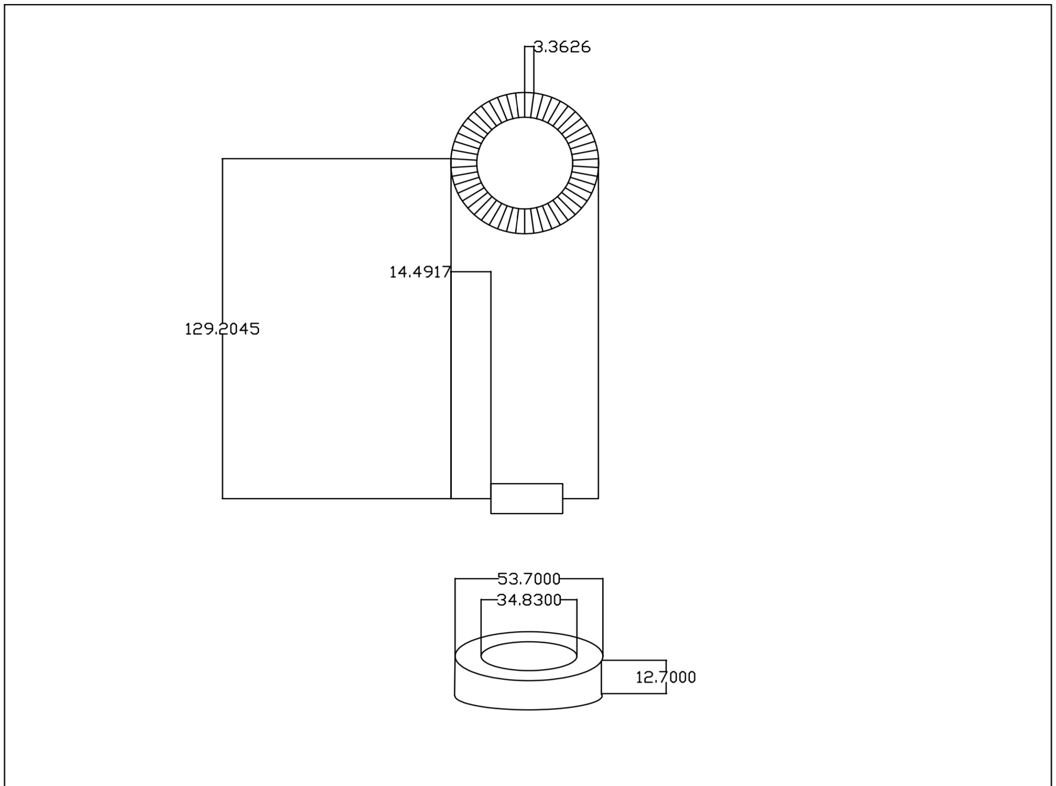
*Sample Dimension refers to the dimensions that include coating. These dimensions do not pertain to the effective area used, as this effective area was stated in the provided core manufacturer datasheet. A correction factor accounts for this where plausible, taking the ratio of Sample Dimension-to-Actual Dimension, multiplying the cross-sectional area with this term (See AMPED standard AMP-STD-0C for this calculation, and for other calculations).

Magnetic Characteristics				
Description	Symbol	Finished Dimension		Unit
Effective Area	A_e	68.9		mm^2
Mean Magnetic Path Length	L_m	139.6		mm
Core Mass	C_M	0.07358107		kg**
Density	D	7650		kg / m^3
Lamination Thickness	L_M	0		µm
Chemistry	Si-Fe		**Grade**	
Anneal			**Impregnation**	Unimpregnated
Core Supplier	MAGNETICS		**Part Number**	01500554K
Wire Supplier	Remington Industries		**Wire Gauge**	24 AWG

Unless explictly noted by the manufacturer, the **Core Mass shown was calculated multiplying the Effective Volume (the **Effective Area** multiplied **Mean Magnetic Path Length**), and the provided **Density** by the manufacturer, all in this table. The **Density** was provided from the manufacturer provided documentation *"2016-Magnetics-Tape-Wound-Cores-Catalog"*.

Design

The design is provided here. In particular, the design used off-the-shelf cores for the comparison between core types.



TITLE	DRAWING NO.	UNITS	DRAWN	DATE
Current Transformer - Magnesil	01	MM	CSB	25JAN2022

PURPOSE	DESIGNER	SCALE	PROJECT	CHECKED	REVISION
Application Testing	MAJ	1:1	CBMM	PRO	--

AMPED ADVANCED MAGNETICS FOR POWER & ENERGY DEVELOPMENT

Primary Turns	1 Turn	Secondary Turns	50 Turns
Design Primary Current	100 A_{pk}	Ideal Turns Ratio	50:1
Load Resistance	5 Ω	Load Resistor Design Heat Disspation (W)	
		at 60 Hz	8.16
		at 1000 Hz	9.99
		at 10000 Hz	10

Design Personnel	
Name	Mark Juds
Title	Research Associate

Section One: Excitation Testing of Current Transformer with Amplifier: Test Procedures and Results.

Purpose.
This test procedure is used to measure the excitation and its efficiency between cores and between measurement of an known laboratory current probe with use of an amplifier.

Test Equipment.
The test equipment shall be used as follows:

Lab Asset No	Description	Manufacturer	Model No	Serial No
WAV0003	Arbitrary Waveform Generator	Keysight Technologies	EDU33212A	CN61310043
AMP0001	High Speed Power Amplifier	NF Electronic Instruments	4025	4025-112
OSC0003	Oscilloscope (500 MHz)	Keysight Technologies	MSOX4054A	MY61260112
PRO0003	Differential Probe	Rigol	RP1025D	2014187
PRO0002	AC / DC Current Probe	Keysight Technologies	1147B	JP61071359
LAB0001	Computer	AMPED	None	None

Test Procedures.

I. Core Loss Testing - Low Signal with Amplifier Setup – Room Temperature – Manual Procedure.

Per AMPED Standard AMP-STD-0C1, below is the procedure for manual operation of equipment for the Low Signal Setup, to be applied as follows. For a more detailed and general procedure to apply the test, refer to the referenced standard described here.

a. Turn on the measurement equipment and allow sufficient time for stabilization (e.g. 20 minutes).

b. Set the Arbitrary Waveform Generator to the following settings.

- Begin with a low signal.
  - Frequency. Set frequency as initial starting point at 60 Hz. Increment based on the desired frequencies necessary to perform measurements.
  - Amplitude. Begin with an amplitude value, in terms of peak-to-peak (V_{PP}), at 10 milli. Increase where deemed appropriate to make sure a fully functioning signal is observed in an acceptable tolerance.

c. Set the Power Amplifier values.

- Be sure to press input cable connected to on (usually A).
- Press the desired gain. Performed in these tests at "X50".

d. Set the Oscilloscope to the following settings.

- Specify Probe Attenuation.
  - Measurements were perfomed with a Keysight 1147B Current Probe has a fixed attenuation ratio of 0.1 V/A and cannot be changed.
  - Voltage Probe from Keysight, the N2792, was used for measurements, and has fixed attenuation ratio of 5:1 after calibration with oscilloscope. Probe with Asset Number PRO0003 was used to acquire data from 60 Hz – 10 kHz.

• All data, 60 Hz – 10 kHz data was captured with High Resolution Settings under Waveform-Acquire Menu.

e. Center the Current Carrying Conductor (25 AWG Magnet Wire) directly in the center of the core for accurate measurement, with the amplifier postiive and negative leads connecting the wire.
f. Place the voltage probe at the burden resistor (output of the current transformer). Multimeter also can be placed at output.
g. Place the current probe before the core, at the start of the current carrying conductor, approximately 10 inches from its beginning.
h. Turn output of Arbitrary Waveform Generator on.
i. Level the output voltage at the offset adjust with flat head screw driver, if possible. Note if probe does not have that capability.

• For data presented, Voltage probe with asset number PRO0009 does not have the capability.

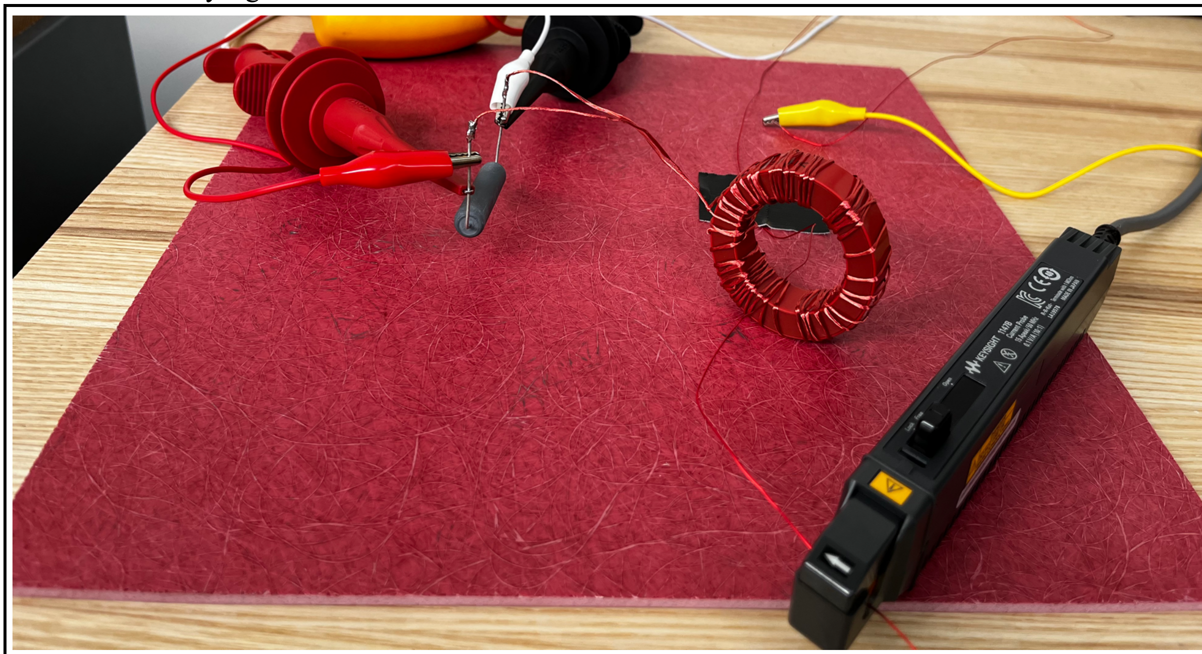
j. Let the Waveform Generator remain outputting a signal for about 90 seconds to ensure pure stability and integrity of the signal, such that any degradation or defects minimize.
k. Examine the Waveform on the Oscilloscope read from the Current Probe on the input side and the Differential Probe on the Output Side.

• Be sure to capture 3 - 5 periods of the excitation signal being applied.
• Look for point of saturation for the core. This can be visually examined when the waveform's maximum value no longer increases. Sine and Triangular waveforms flatten, Square becomes more in a curve. See Data Presentation for examples.

l. Auto zero and Degauss the Current Probe before step i. Also Degauss where Average Current Waveform value climbs above an acceptable tolerance of +/- 10 mA.
m. Repeat steps a - j for Square Waveform, Triangle Waveform, or other excitation waveforms for examined interest.
n. Record relevant data for Data Presentation.

Setup.

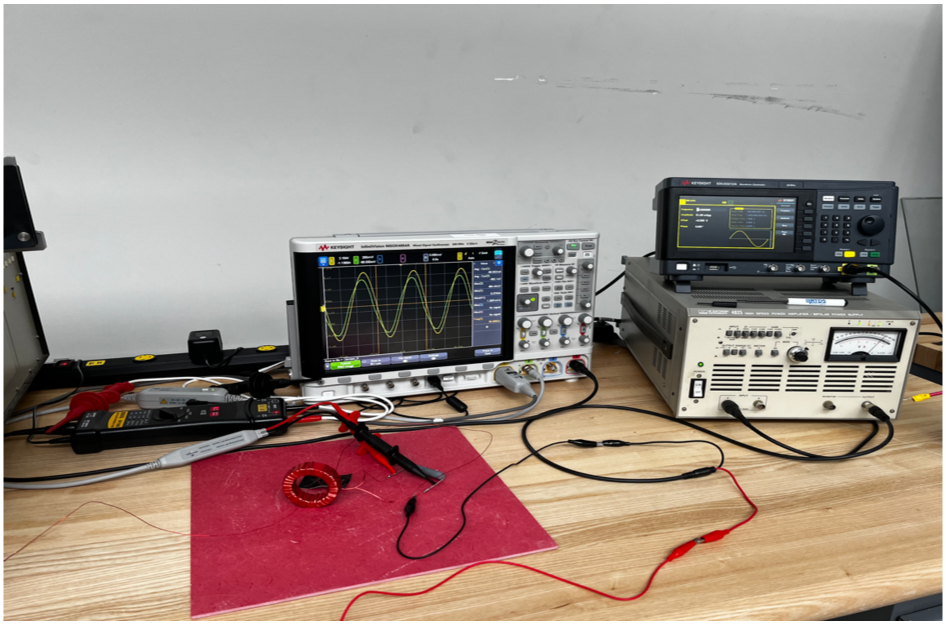
Excitation Testing with Amplifier. Configure the test equipment as shown below, with one figure showing the actual test setup, another as the block diagram, and one illustrating the placement of the current carrying conductor.



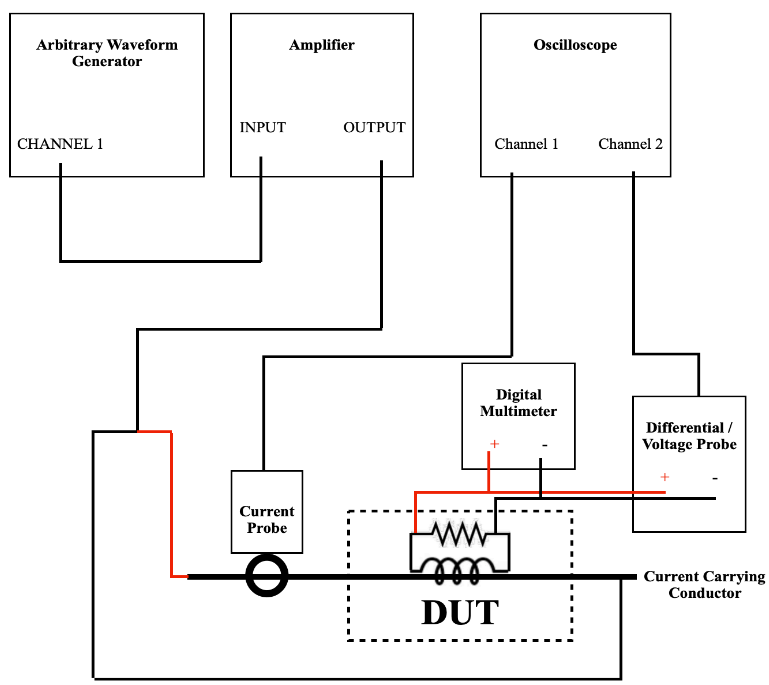
Current Transformer Testing - Low Voltage with Amplifier. Complete Current Transformer.

Setup.

Excitation Testing with Amplifier. Configure the test equipment as shown below, with one figure showing the actual test setup, and another as the block diagram.



Current Transformer Testing - Low Voltage with Amplifier. Typical Test Setup.



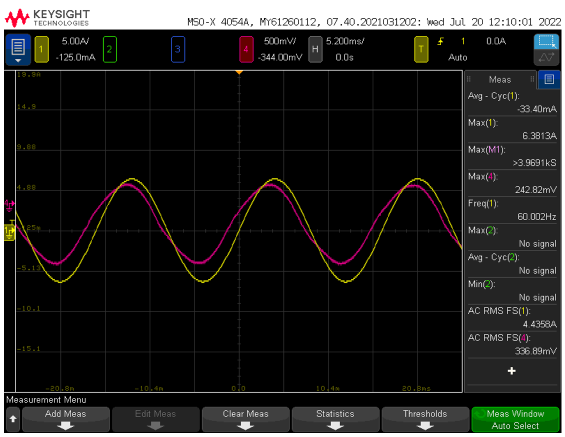
Current Transformer Testing - Low Voltage with Amplifier. Typical Test Setup: System Block Diagram.

Data Presentation.

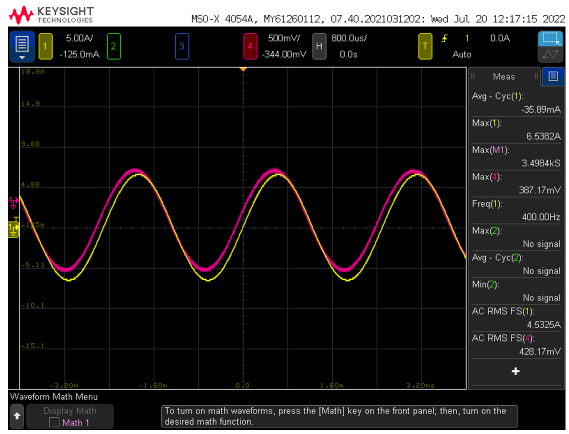
In this section, data is presented as each section indicates below.

a. Current Transformer Excitation Waveforms.

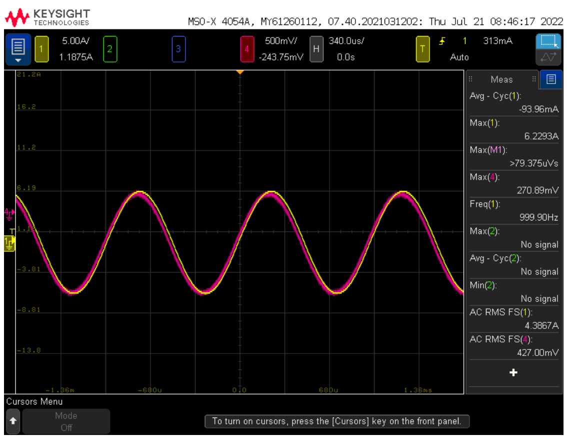
Excitation Waveforms: Sinusoidal



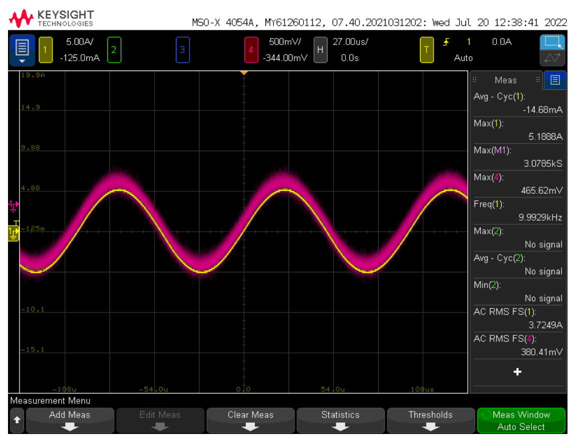
Sample Sinusoidal Excitation Waveforms. Sinusoidal Signal. 39.00 mV_{pp} 60 Hz, Amplifier Gain X50.



Sample Sinusoidal Excitation Waveforms. Sinusoidal Signal. 41.00 mV_{pp} 400 Hz, Amplifier Gain X50.

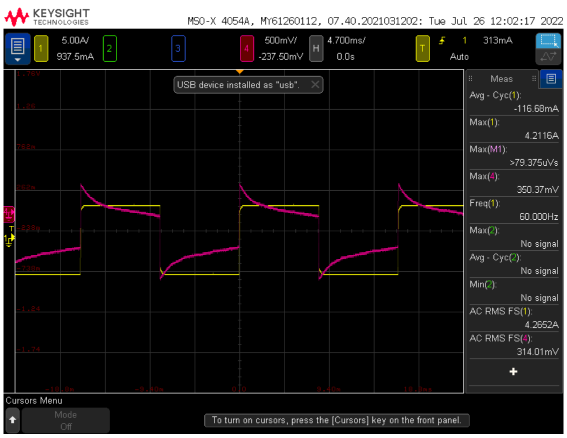


Sample Sinusoidal Excitation Waveforms. Sinusoidal Signal. 41.00 mV_{pp} 1 kHz, Amplifier Gain X50.

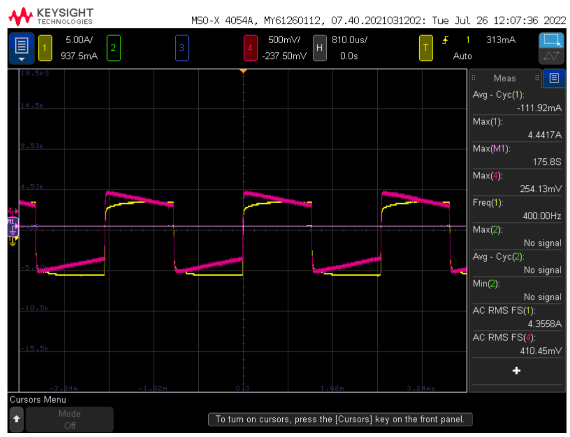


Sample Sinusoidal Excitation Waveforms. Sinusoidal Signal. 41.00 mV_{pp} 10 kHz, Amplifier Gain X50.

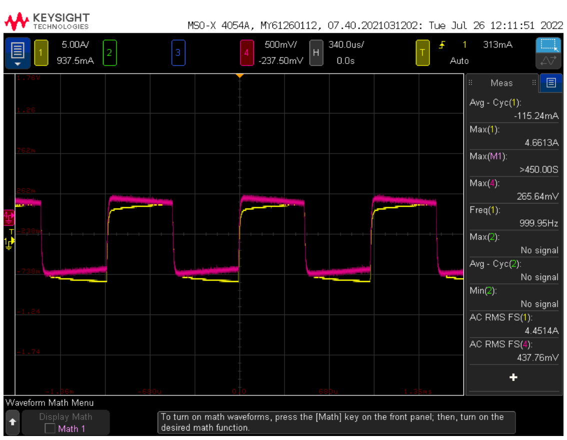
Excitation Waveforms: Square



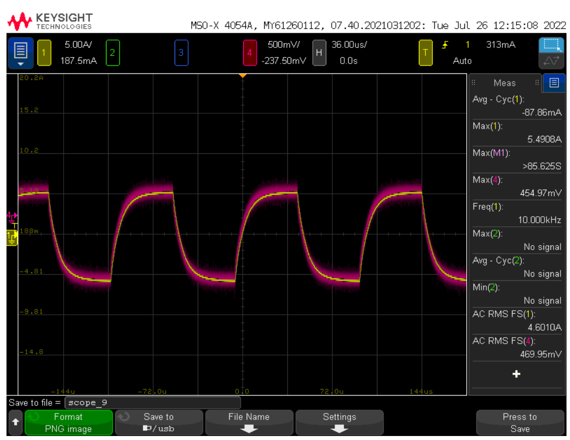
Sample Square Excitation Waveforms. Sinusoidal Signal. 39.00 mV_{pp} 60 Hz, Amplifier Gain X50.



Sample Square Excitation Waveforms. Sinusoidal Signal. 41.00 mV_{pp} 400 Hz, Amplifier Gain X50.

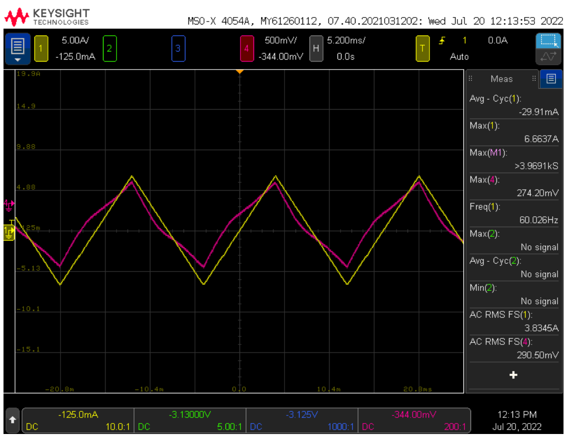


Sample Square Excitation Waveforms. Sinusoidal Signal. 41.00 mV_{pp} 1 kHz, Amplifier Gain X50.

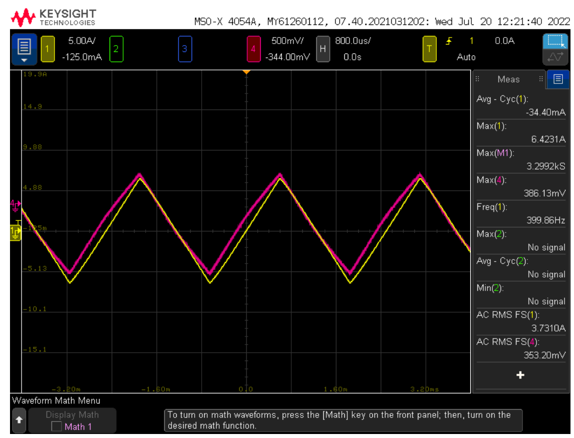


Sample Square Excitation Waveforms. Sinusoidal Signal. 41.00 mV_{pp} 10 kHz, Amplifier Gain X50.

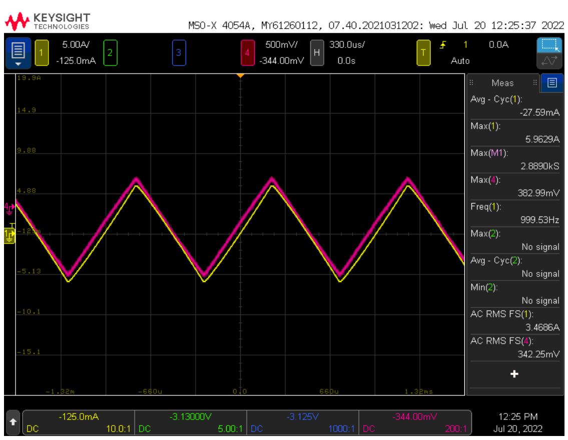
Excitation Waveforms: Triangular



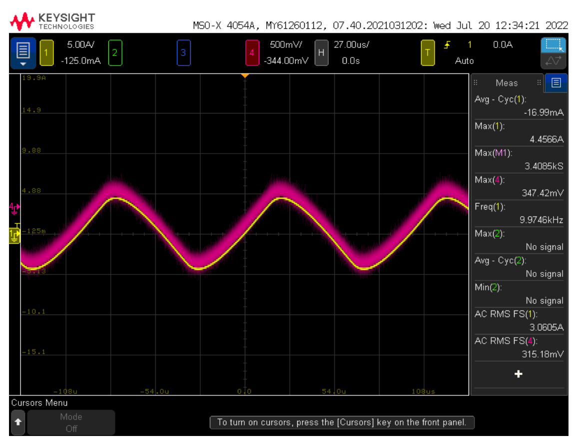
Sample Triangular Excitation Waveforms. Sinusoidal Signal. 39.00 mV_{pp} 60 Hz, Amplifier Gain X50.



Sample Triangular Excitation Waveforms. Sinusoidal Signal. 41.00 mV_{pp} 400 Hz, Amplifier Gain X50.

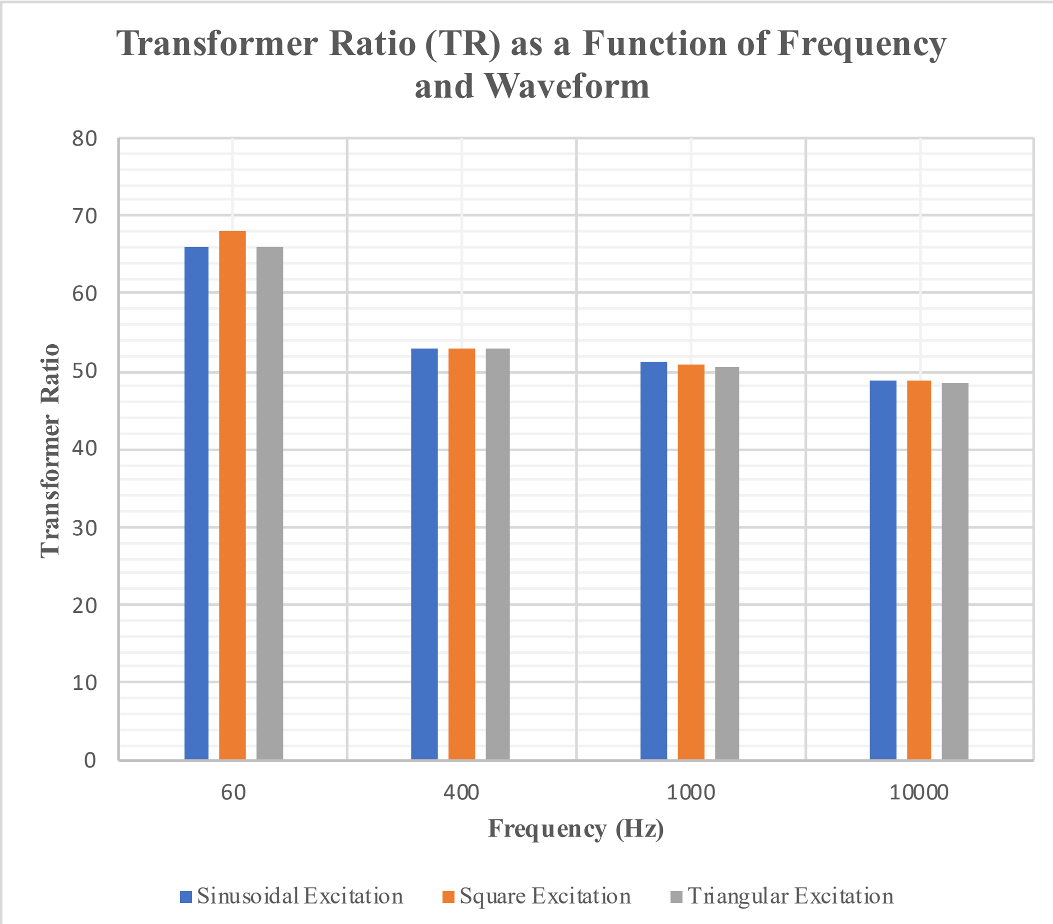


Sample Triangular Excitation Waveforms. Sinusoidal Signal. 41.00 mV_{pp} 1 kHz, Amplifier Gain X50.



Sample Triangular Excitation Waveforms. Sinusoidal Signal. 41.00 mV_{pp} 10 kHz, Amplifier Gain X50.

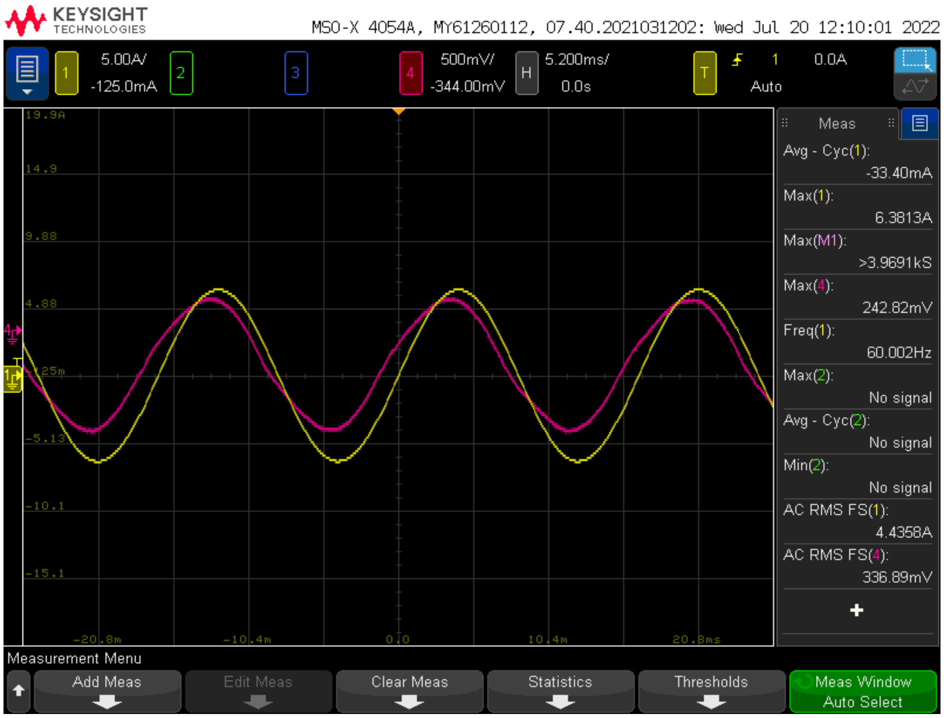
b. Transformer Ratio of Variable Frequency and Excitation Signals.

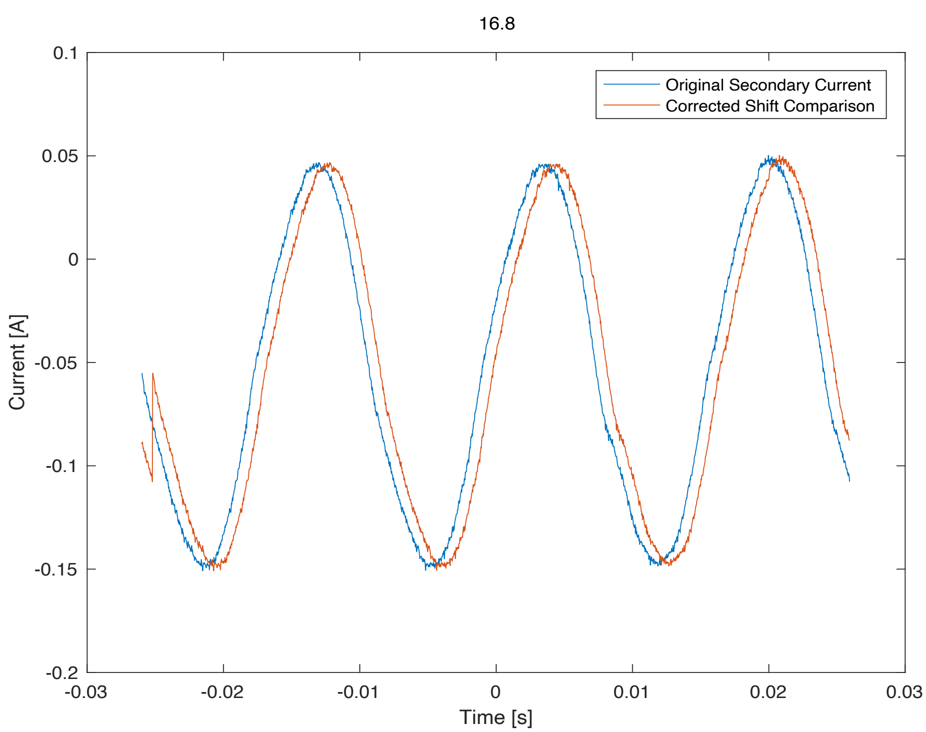


Excitation Signal	Frequency	Primary Current	Secondary Voltage	Burden Resistance	Secondary Current	Transformer Ratio
Sinusoidal	60	4.4358	0.33689	5	0.067378	65.8345454
	400	4.5325	0.42817	5	0.085634	52.92874326
	1000	4.3867	0.427	5	0.0854	51.36651054
	10000	3.7249	0.38041	5	0.076082	48.9590179
Square	60	4.2652	0.31401	5	0.062802	67.91503455
	400	4.3558	0.41045	5	0.08209	53.06127421
	1000	4.4514	0.43776	5	0.087552	50.84292763
	10000	4.601	0.46995	5	0.09399	48.95201617
Triangular	60	3.8345	0.2905	5	0.0581	65.99827883
	400	3.731	0.3532	5	0.07064	52.81710079
	1000	3.4686	0.34225	5	0.06845	50.6734843
	10000	3.0605	0.31518	5	0.063036	48.5516213

c. Phase Shift at Variable Frequencies and Excitation Signals.

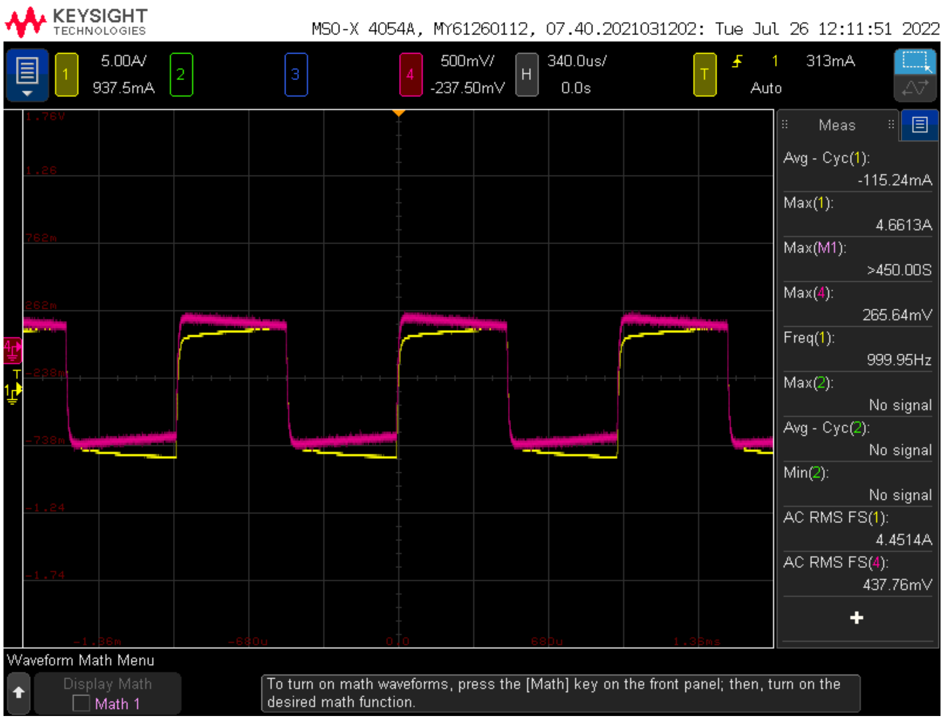
Excitation Waveforms: Sinusoidal

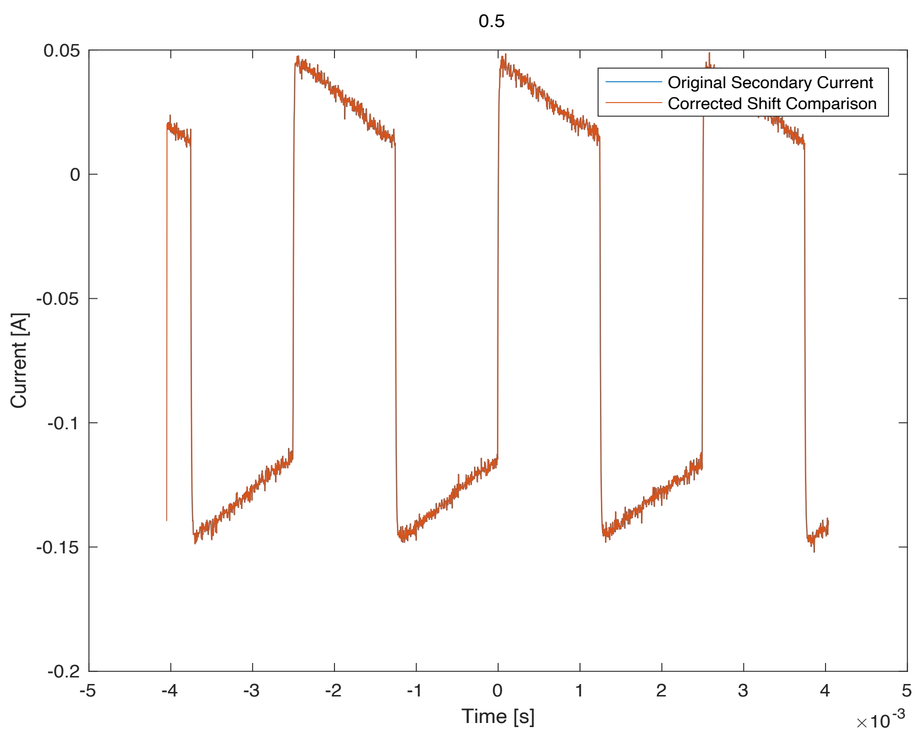




(a) Sinusoidal Excitation Waveform. Sinusoidal Signal. 39.00 mV_{pp} 60 Hz, Amplifier Gain X50. (b) Corrected Output Signal Illustrating Phase Shift.

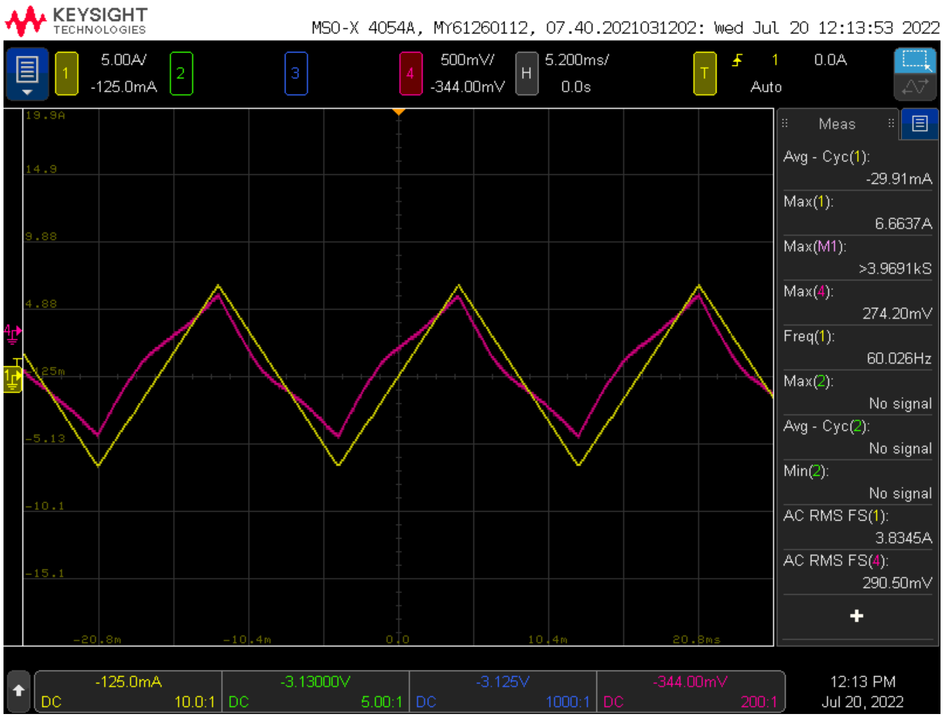
Excitation Waveforms: Square

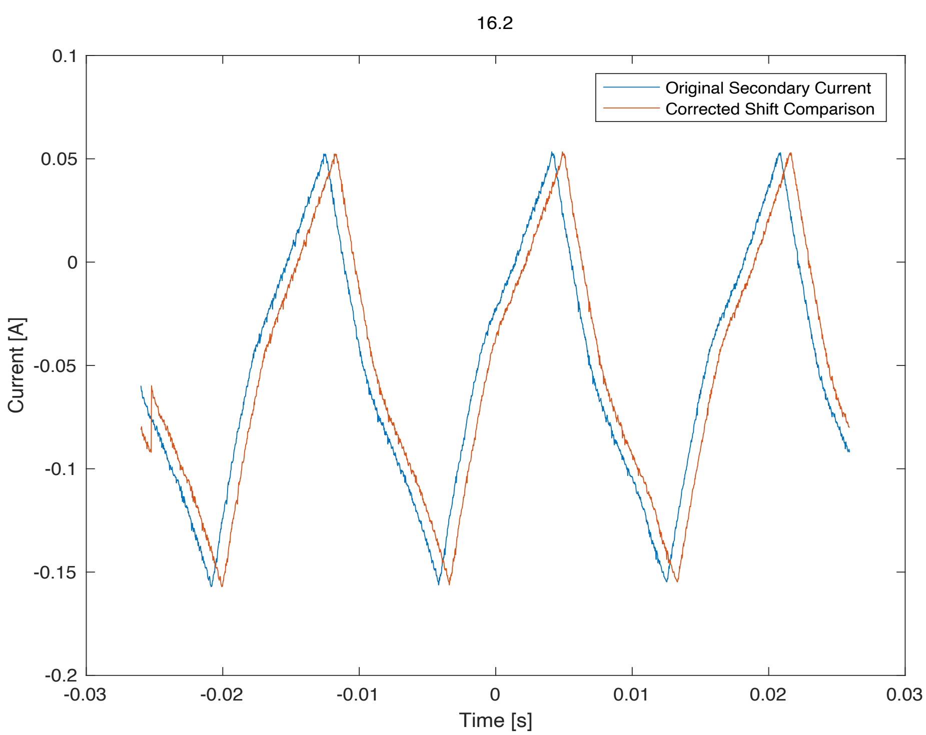




(a) Sinusoidal Excitation Waveform. Sinusoidal Signal. 41.00 mV$_{pp}$ 400 Hz, Amplifier Gain X50. (b) Corrected Output Signal Illustrating Phase Shift.

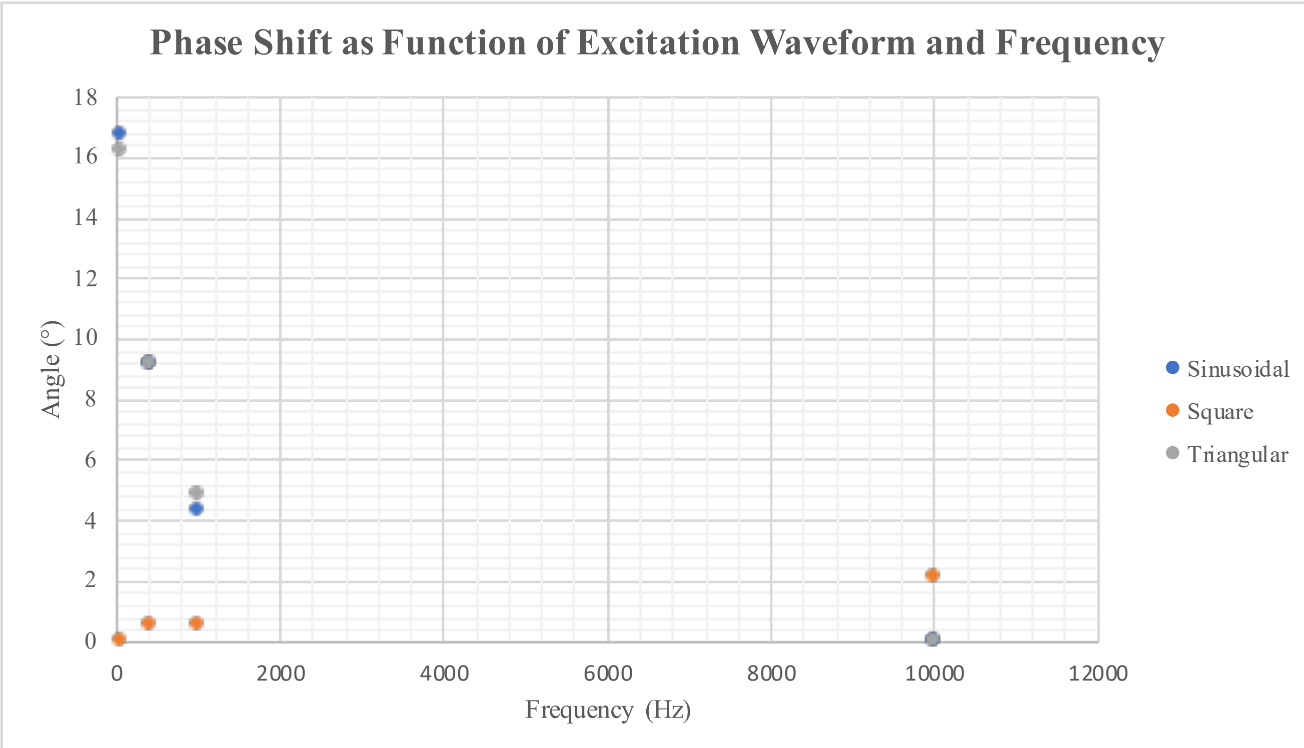
Excitation Waveforms: Triangular





(a) Sinusoidal Excitation Waveform. Sinusoidal Signal. 39.00 mV_{pp} 60 Hz, Amplifier Gain X50. (b) Corrected Output Signal Illustrating Phase Shift.

Phase Shift Summary



Excitation Signal	Signa Operating Frequency	Phase Shift Between Input to Output
Siusoidal	60	16.7651°
	400	9.1892°
	1000	4.3243°
	10000	0.0038°
Square	60	0.0039°
	400	0.5405°
	1000	0.5395°
	10000	2.1622°
Triangular	60	16.2243°
	400	9.1802°
	1000	4.8649°
	10000	0.0036°