Measurements International
Metrology is Our Science, Accuracy is Our Business™

Accurate Ratio Measurements of Two AC Signals

Over the last decade, industry requirements for increasing efficiency and reducing losses have pushed measuring capabilities more and more towards tighter and tighter tolerances and limits. Strict conditions have also implied the need for testing equipment capable of meeting those accuracies.

Measurements International (MIL) has always been committed to providing customers with state-of-the-art instruments and systems as a solution for their more rigorous metrological needs.

Introduction

Measuring the ratio between two signals has been a cornerstone for calibration methods based on comparing an unknown magnitude to a known or reference magnitude. Many MIL products are based on this principle. The current comparator transformer (CCT) has been the heart of the designs for AC signal applications.

Until present days, this CCT technology is capable of fulfilling the accuracy requirements of most applications. However, there are some disadvantages related to size, cost, hardware complexity, and time to display readings.

Advances in modern science and technology have brought new methods and solutions to overcome some of those disadvantages.

Years of research and improvements in signal sampling and processing led MIL to develop new products and fulfill the latest industry requirements.

This document will analyze the features and benefits of MIL new AC Ratio Bridge technology and its possible applications.

MI New AC Ratio Bridge

The new MI AC Ratio Bridge is based on simultaneous sampling technology. It combines precision scaling of analog input signals and digital sampling and processing of those signals. This instrument uses high precision and ultra low noise 24-bit ADCs synchronized for simultaneous sampling allowing high resolution and excellent performance within few parts in 10^6.

The development of this product aims at applications required to establish the magnitude and phase displacement ratio between two AC currents or voltages. That makes the calibration of conventional instrument current and voltage transformers the most popular application for this unit.

There are three base models of the MI AC Ratio bridge. The 7070A-I, for calibrating conventional current transformers (CT) or measuring the ratio of two AC currents.

The 7070A-U, for calibrating conventional voltage transformers (VT) or measuring the ratio of two AC voltages. Whereas the 7070A-UI has extended capabilities for both CTs and VTs.

Technical details about input ranges and specifications are described in the 7070A datasheet found following this link: https://mintl.com/products/7070a-ui-ac-ratio-bridge/

The modular design of the 7070A AC Ratio bridge makes this instrument very flexible and customizable to various applications. For any special request, contact your local MI representative or email us at: sales@mintl.com

The unit comes in a rack mount 4U enclosure usable as a bench top instrument.

Figure 1 7070A AC Ratio Bridge

The 7070A is equipped with a 10.1" touchscreen making its operation very easy with control buttons to navigate different menus and screens. It has a USB port available on the front panel for saving measurement data. The main measurement screen displays all relevant test parameters. Additional parameters like the total harmonic distortion (THD) percentage, signal waveshapes, etc., are also available when you browse through other screens using the arrow buttons.

The input terminals on the rear panel could differ depending on the standard or customized model. The instrument can be fully controlled from the front panel display and has several features like autosaving measurement data, settings for multi-measurements with selectable time between measurements, entering unit under test (UUT) rated parameters, etc.

Although the unit has all the features to be operated as a stand-alone instrument, it is also equipped with remote control capability. It has two user-selectable interface options, IEEE-488.2 and RS-232, only one interface can be used at a time.

This instrument complies with IEC and ANSI Standards for calibration of CTs and VTs.

Figure 2 shows the block diagram of a 7070A-UI unit with both input signal modules, current, and voltage.

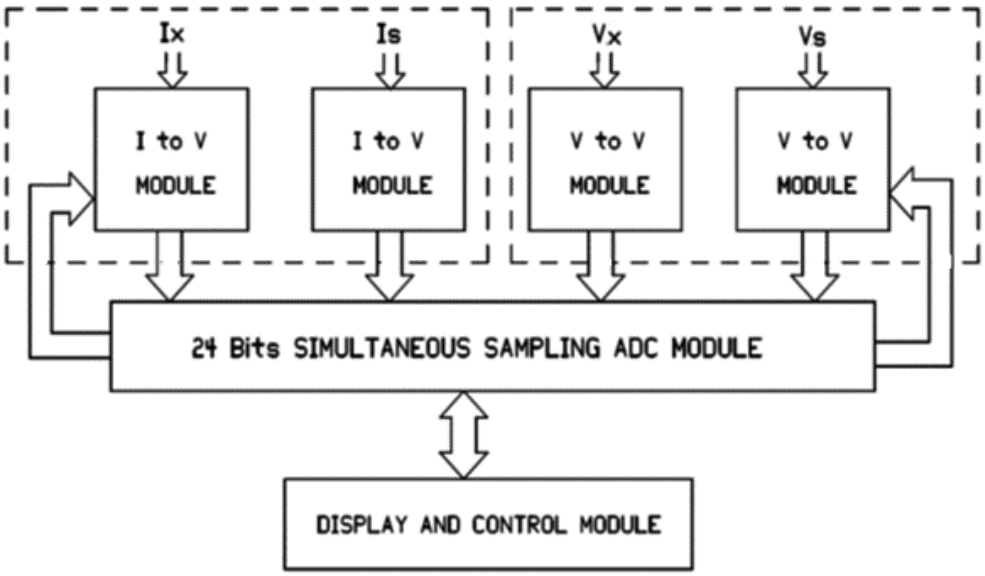

Figure 2 7070A-UI Block Schematic

Each input module accommodates and converts the input signal to an AC voltage suitable to be measured by the ADC module. Multiple input ranges allow maximizing the level at the input of the ADC for best performance.

MI 7070A Ratio Bridge Applications

As mentioned above, the main application for the 7070A series of ratio bridges is for calibrating conventional instrument transformers (CTs and VTs).

However, the instrument is not limited to this application only. Upon request, the instrument is customizable with additional testing features. For example, the 7070A-UI model could also measure AC power using one voltage and one current input channel.

- Calibration of Conventional Current Transformers:

  Instrument current transformers are widely used in different industrial facilities for monitoring, measuring, and protection purposes. Most of them need to be calibrated to ensure the veracity of the results.

  One of the more traditional methods is by direct comparison to a known reference CT where both CTs, reference CT, and CT under test are fed with the same primary current. Consequently, the secondary outputs are compared.

  The MI 7070A also uses this calibration approach. However, it offers some advantages over other systems. Some other manufacturer instruments or systems require balancing time before getting actual readings. The 7070A starts displaying the result instantly when the primary current is applied.

  This feature is useful to quickly identify any possible connection mistake, malfunctioning, or incorrect set up before reaching full test conditions.

Another advantage of the 7070A Ratio bridge is the capability of each input to operate on a different input range. Many other systems need to operate at ratios close to 1:1, requiring the user to have many reference CTs to cover the wide range of UUT ratios.

With the 7070A and a few reference CTs, it is possible to cover all available instrument transformer ratios. This feature also reduces the amount of equipment for onsite calibration applications.

Figure 3 shows two possible set-ups for calibrating CTs, one using single-stage reference CT and another utilizing a two-stage compensated reference CT.

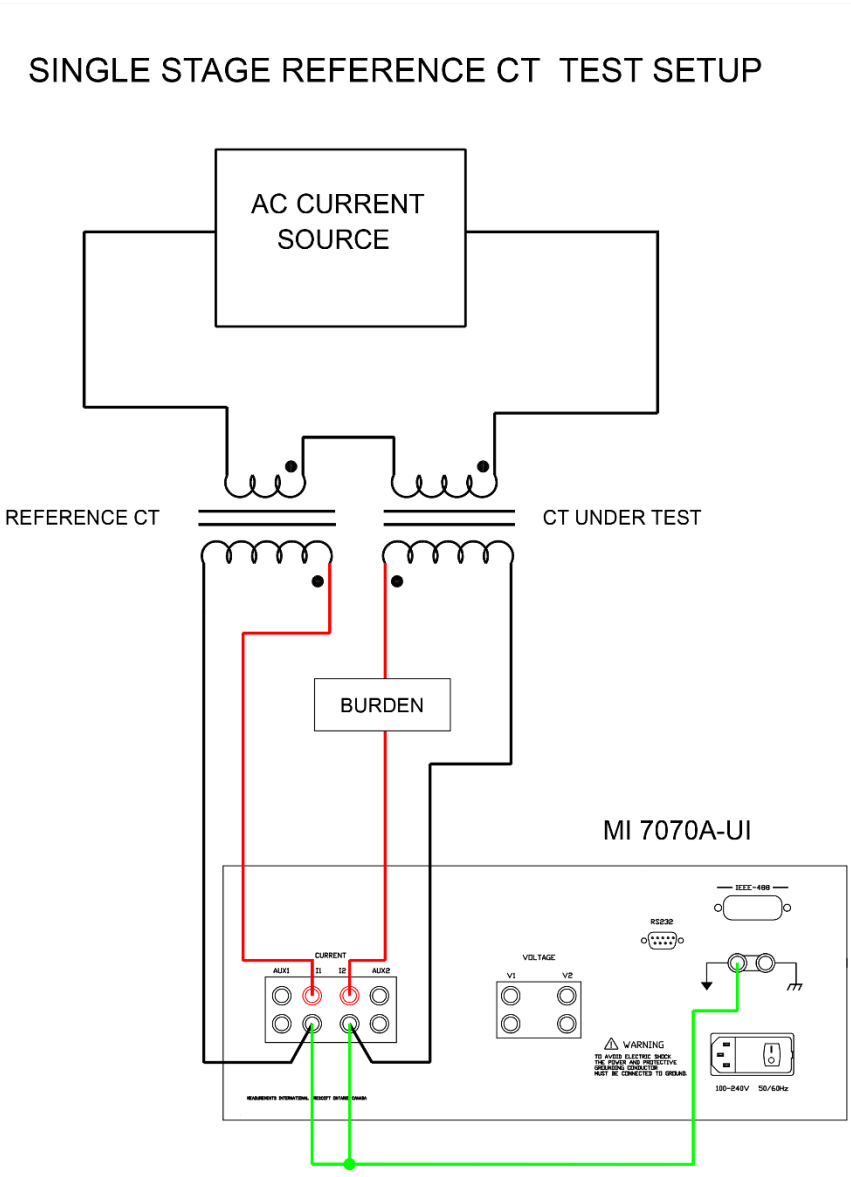

Figure 3 Single-Stage Reference CT Block Schematic

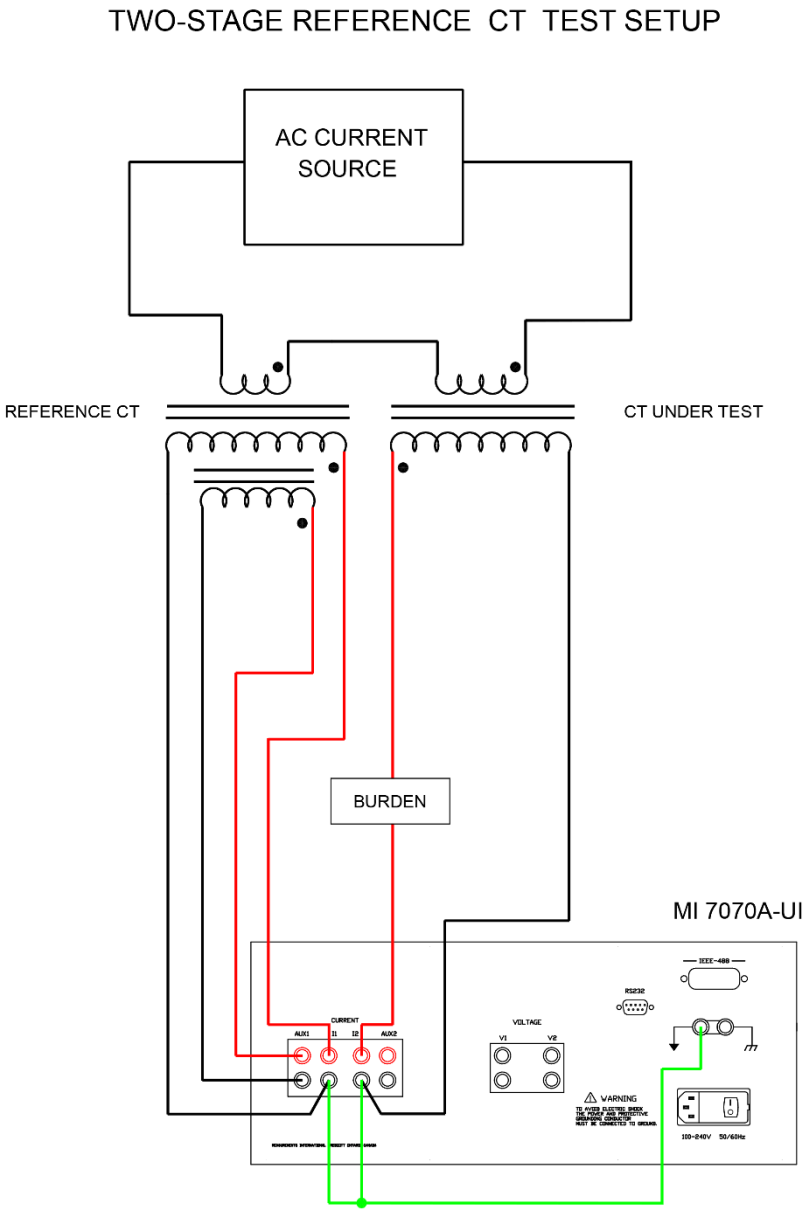

Figure 4 Two-Stage Compensated CT Measurement Setup

Two-stage compensated CTs are more accurate than single-stage or non-compensated CTs. MIL also offers various precision two-stage compensated CTs that can be used directly with the 7070A ratio bridge, which has compensated current input terminals available.

In the CT TESTING MODE menu, the user can enter the calibration information of the reference CT and the rated and nominal parameters, model, serial number, etc. This information will be recorded in the measurement file when saved. The reference CT calibration data is considered to calculate the overall ratio reading for the UUT. Similarly, rated values and other information can be entered for the UUT.

- Calibration of Conventional Voltage Transformers:

  All features and benefits available for calibrating CTs are also present in VT TESTING MODE. In this case, the 7070A Ratio bridge measures the input signals applied to the voltage input terminals.

  Figure 5 shows the set-up diagram for VT calibration using MI 7070A ratio bridge and a reference voltage transformer.

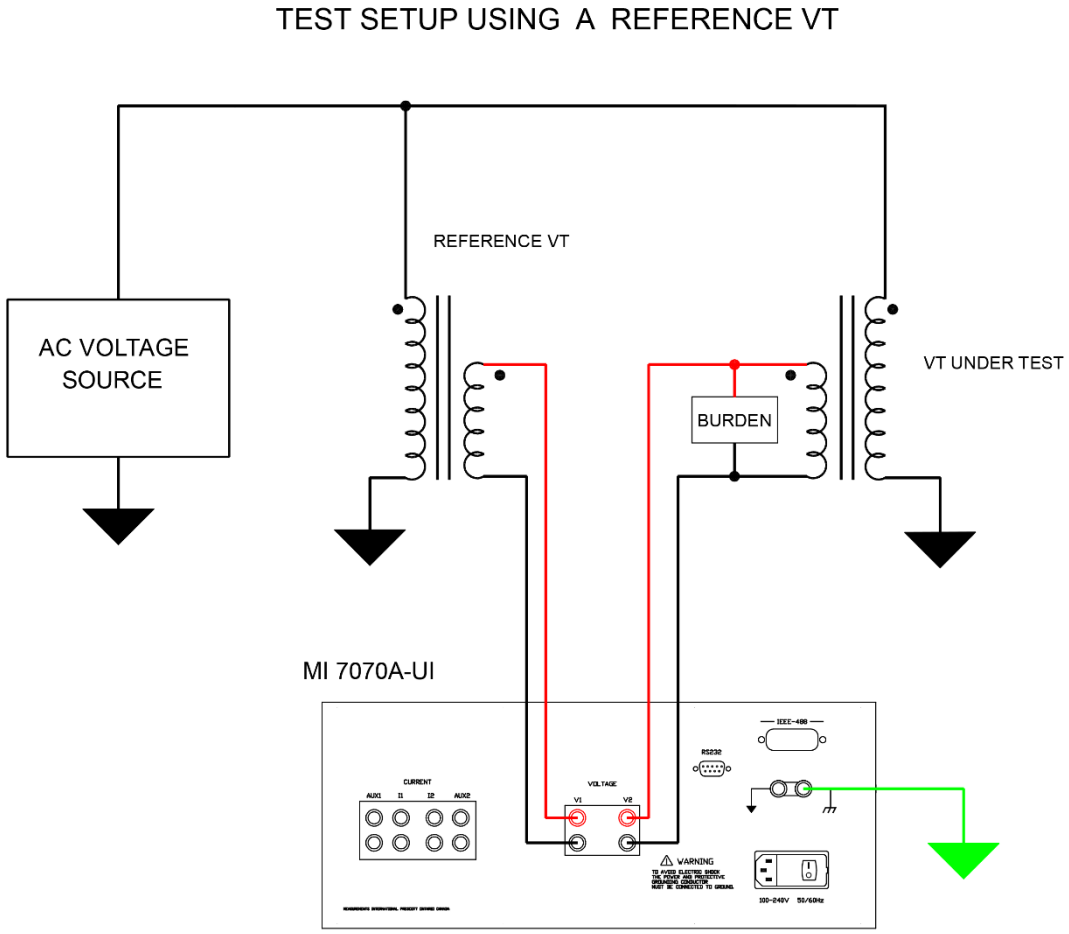

Figure 5 VT Calibration Against a Standard VT

Calibrating VTs using the configuration shown above could require having a complete set of Standard Reference VTs with different rated voltages and ratios to cover the full range of possible UUTs. This could be costly and hard to use in field (onsite) conditions.

A possible solution to overcome that is to use active High Voltage dividers like MI 2500 series in the set-up. Using one of these dividers and a gas-filled reference HV capacitor it is possible to cover a wide range of primary voltages and ratios. This approach significantly reduces the number of HV reference standards to use and provides very high accuracy.

Figure 6 shows the set-up for calibrating VTs using MI 2500 series active divider.

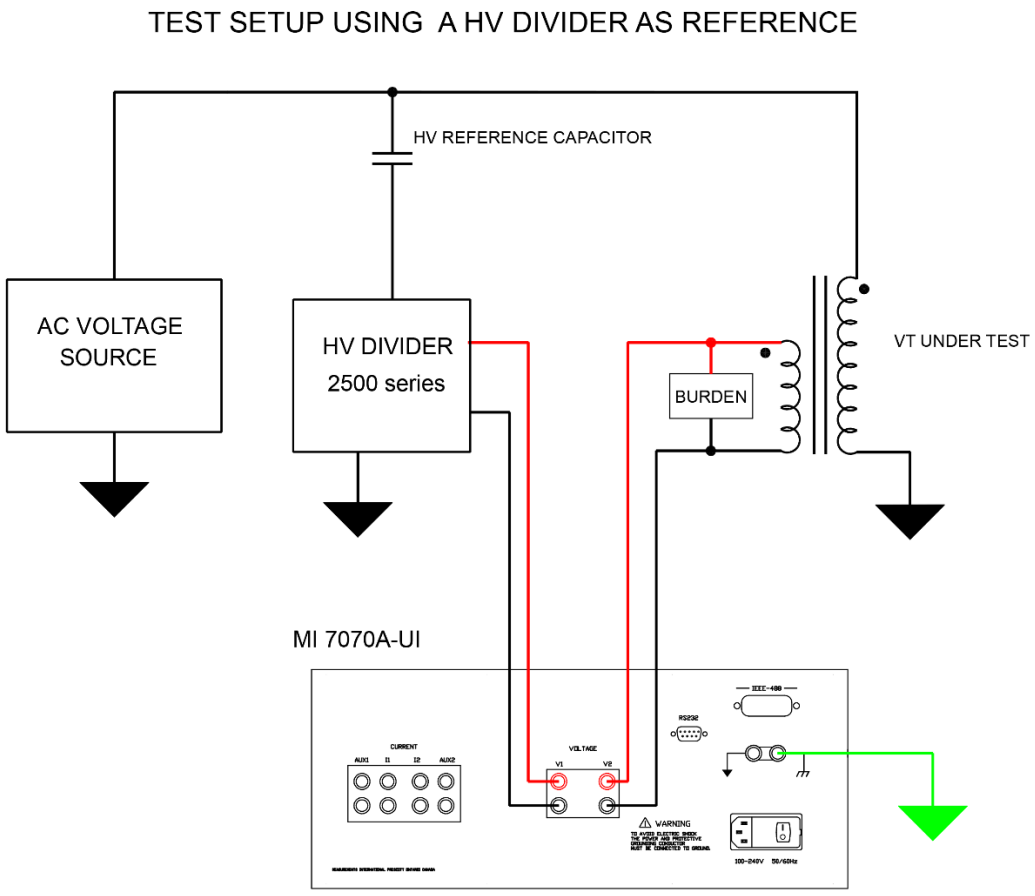

Figure 6 VT Calibration Against an Active Divider

Another possible configuration using the 7070A ratio bridge for calibrating VTs is using a special 7070A with additional input to connect an HV reference capacitor directly. With this set-up customers might not cover as much input voltage range as when using an HV divider unless you use more than one HV reference capacitor. However, users with a narrower test voltage range or those who already have HV reference capacitors could be a cost-effective solution.

Conclusion

Making accurate measurements of two AC signals to determine the magnitude ratio and phase displacement between them has been a challenge for many laboratories and test facilities. A possible solution for these complex and high-precision needs is now available with the MI AC Ratio Bridge (7070A series).

This instrument's versatility, simplicity in use, high accuracy, and flexible customization make it a perfect fit for a wide range of AC measurement applications.