

SWR200 Sine Wave Reference Ideas

PROGRAMMABLE PRECISION AC SOURCE

Many techniques are available for providing precision DC references and precision programmable DC references. The programmable DC reference in reality is a digital to analog converter.

It can be difficult to secure an amplitude stable source of AC and even more difficult to provide a programmable output. However, the SWR200 combined with the availability of precision multiplying digital to analog converters (DAC's) which can accept bipolar inputs makes creating a programmable AC reference much easier.

In this application, the SWR200 is simply used as a reference for a high accuracy 16 bit multiplying DAC. The circuit example is shown in Figure 1.

The SWR200 provides the reference input for the AD569 which is capable of full four-quadrant operation. The output voltage is a function of the digital code input to the AD569 according to the following equation:

$$AC V_o = \frac{DIG. INPUT}{2^{16}} \times V_{REF}$$

In applications where the final output may need to be scaled up for voltage or current, an external power op amp may be used. See the connection shown in Figure 2. This scaling method can be used to provide very high levels of programmable voltage or current. For further information on connections to the AD569, refer to the Analog Devices data sheet.

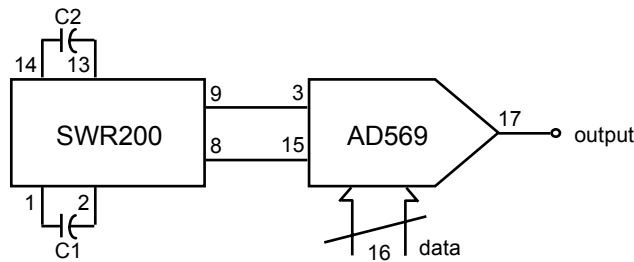


FIGURE 1. SWR200 AS EXTERNAL REFERENCE FOR MULTIPLYING DAC.

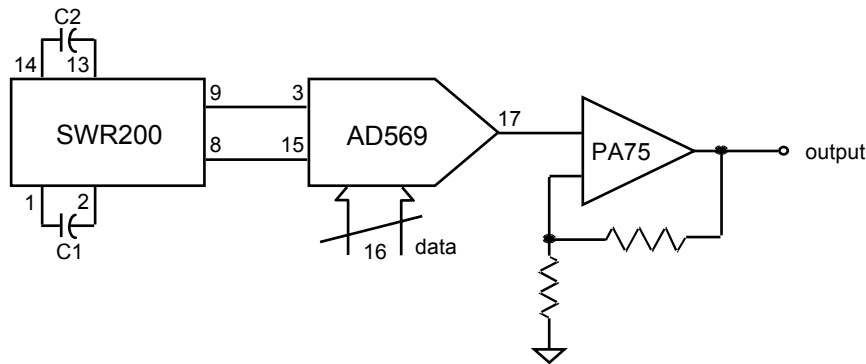


FIGURE 2. SWR200 WITH EXTERNAL POWER OP AMP.

PRECISION LVDT SYSTEMS

LVDT's or Linear Variable Differential Transducers are used for linear position sensing. Applications for these devices include position control servo systems such as aircraft control surfaces, paving equipment and automated laser trim systems.

The LVDT is in essence a transformer with a single input winding and two output windings on a common moveable core. This moveable core is connected to the portion of the system where it is desired to sense position. In the 'centered' position the output of each winding is equal in amplitude and will cancel in the LVDT demodulator for a zero

output. As the core deflects, one winding will generate a larger amplitude than the other winding. This difference in amplitude will show direction as the polarity of the demodulated output, and distance as the amplitude.

When the LVDT is used in closed loop control systems where the servo loop will always return to zero, then accurate control of amplitude will not be necessary. An example is a paving machine where the LVDT senses tilt and the servo system returns the machine to the level state.

In position sensing the amplitude output of the LVDT will be a function of position. The accuracy to which this position can be resolved will then be a function of the amplitude accuracy of the LVDT drive signal. One way to express the accuracy required here is to take the case of the demodulated LVDT output being digitized for input to computer. Then accuracies can be expressed in bit levels. A 12-bit system, for instance, will be required to resolve 1 part in 4096, this translates to an accuracy level of 0.01%.

When temperature variations are factored into the system accuracy, the requirements for an LVDT reference become very demanding. For the system to maintain 12 bit accuracy to 1 LSB from -55 to 125°C would require system drift of less than 1.4 ppm/°C, of which reference drift is only one component. This places extreme demands on reference drift requirements, pointing out the need for low reference drift such as that provided by the SWR200.

The basic LVDT system configuration block diagram is shown in Fig. 3. The reference is a sine wave oscillator, the output of which will usually need to be buffered by a high-current or high-power amplifier. This provides the stimulus to the primary winding of the LVDT. The secondary output of the LVDT can be demodulated in a number of ways. The simplest would be full wave rectifiers on each secondary connected in series opposing to cancel. This is most useful when zero or center sensing is desired. High accuracy applications will require synchronous demodulation using the stimulus signal for synchronization. The output is demodulated and filtered to a DC voltage representing position.

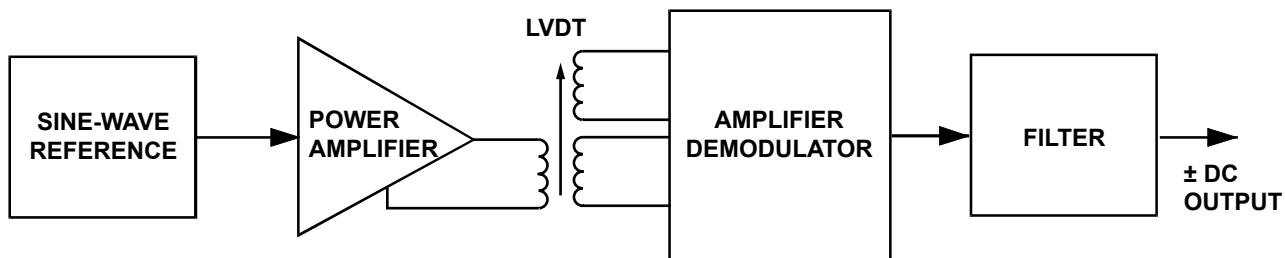


FIGURE 3. POSITION SENSOR BLOCK DIAGRAM

In an actual application shown in Figure 4, a Sine Wave Reference is used as a reference for the sine wave drive. The objective in the LVDT driver is to maintain the tightest possible control over drive amplitude. The power amplifier selected to buffer the sine wave should have good AC accuracy specifications; in particular, open loop gain should be as high as possible. Drift of AC voltage vs. temperature is one of the key specifications of the SWR200 making it easy to determine the effect on the error budget of the oscillator. Errors over temperature associated with the op amp are best controlled by using an amplifier with the highest possible open loop gain. But don't just look at the amplifier open loop gain specification. Many high open-loop gain amplifiers are optimized for DC accuracy, and the open loop gain at the frequency at which the LVDT is driven may be very low. So keep an eye on the amplifier gain-bandwidth product and Bode plots as well. Using the amplifier in the inverting configuration will provide maximum linearity and eliminate errors due to common-mode effects.

Frequently offset and input related parameters are used to specify and refer to "high accuracy" op amps, but in this case, DC errors can be ignored by using AC coupling. When using AC coupling, proper capacitor sizing along with the use of a high quality capacitor will help to preserve the high system AC accuracy. High accuracy is insured by including the output coupling capacitor within the AC feedback loop of the amplifier. A separate DC feedback loop insures a minimum of power amplifier offset to insure maximum voltage swing capability.

Some LVDTs may not require nearly as much power to drive as the circuit shown here can provide and there are a number of other amplifier choices at lower power levels. But the circuit shown here is especially useful in multiple LVDT systems using a single precision source. It should be mentioned that in such applications it is possible to have long cable runs to some LVDTs and use of the lowest possible frequency will insure best accuracy.

Figure 4 shows a representative circuit of an LVDT demodulator using a synchronous demodulator. Many components are available to implement this function ranging from analog switches to switched input op amps. The synchronous demodulator requires a timing reference input from the primary of the LVDT. Some phase adjustment of the timing signal should be provided due to phase shifts from cabling and the LVDT itself. The demodulator is followed by a stage of active filtering to provide a position indicating DC output.

Output from the demodulator can be either a positive or negative voltage with the polarity indicating the direction of deflection from center. The voltage value of the signal represents the distance of deflection.

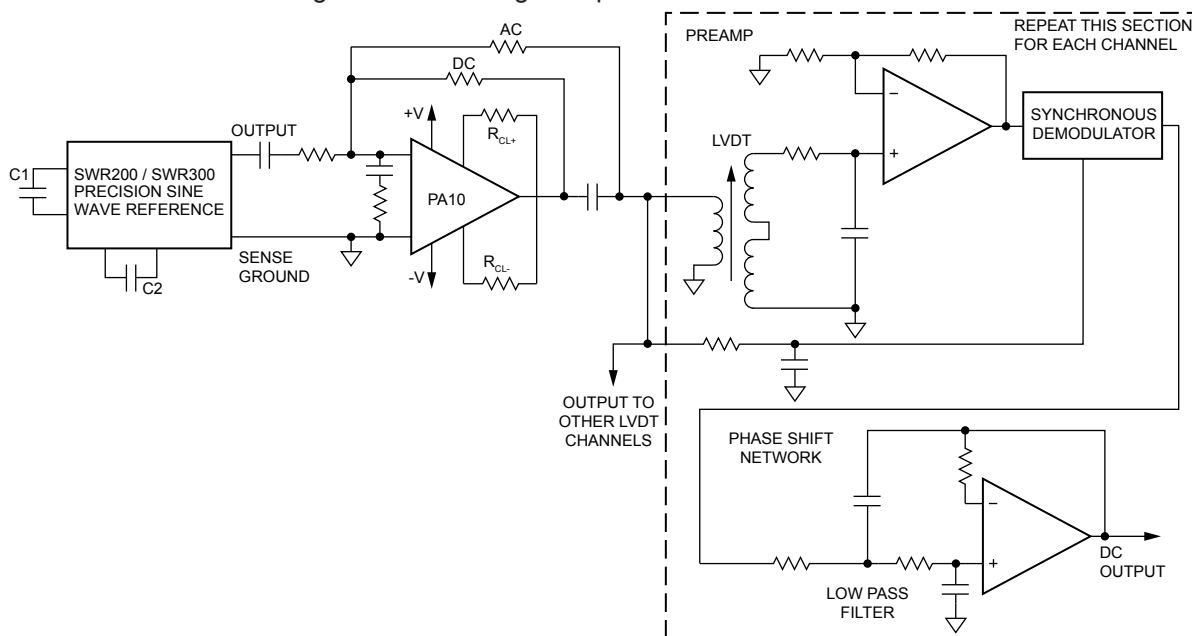


FIGURE 4. SWR200 AND POWER AMP IN MULTIPLE-LVDT SYSTEM.

NEED TECHNICAL HELP? CONTACT APEX SUPPORT!

For all Apex Microtechnology product questions and inquiries, call toll free 800-546-2739 in North America.

For inquiries via email, please contact apex.support@apexanalog.com.

International customers can also request support by contacting their local Apex Microtechnology Sales Representative.

To find the one nearest to you, go to www.apexanalog.com

IMPORTANT NOTICE

Apex Microtechnology, Inc. has made every effort to insure the accuracy of the content contained in this document. However, the information is subject to change without notice and is provided "AS IS" without warranty of any kind (expressed or implied). Apex Microtechnology reserves the right to make changes without further notice to any specifications or products mentioned herein to improve reliability. This document is the property of Apex Microtechnology and by furnishing this information, Apex Microtechnology grants no license, expressed or implied under any patents, mask work rights, copyrights, trademarks, trade secrets or other intellectual property rights. Apex Microtechnology owns the copyrights associated with the information contained herein and gives consent for copies to be made of the information only for use within your organization with respect to Apex Microtechnology integrated circuits or other products of Apex Microtechnology. This consent does not extend to other copying such as copying for general distribution, advertising or promotional purposes, or for creating any work for resale.

APEX MICROTECHNOLOGY PRODUCTS ARE NOT DESIGNED, AUTHORIZED OR WARRANTED TO BE SUITABLE FOR USE IN PRODUCTS USED FOR LIFE SUPPORT, AUTOMOTIVE SAFETY, SECURITY DEVICES, OR OTHER CRITICAL APPLICATIONS. PRODUCTS IN SUCH APPLICATIONS ARE UNDERSTOOD TO BE FULLY AT THE CUSTOMER OR THE CUSTOMER'S RISK.

Apex Microtechnology, Apex and Apex Precision Power are trademarks of Apex Microtechnology, Inc. All other corporate names noted herein may be trademarks of their respective holders.