

Rohde & Schwarz products: R&S® AM300

Phase-Synchronized Signal Generation with two R&S® AM300

This application sheet describes how to use two or more Arbitrary-/Function Generators R&S® AM300 to generate multi-phase-synchronized signals, which are required in some applications.



Contents

1	Overview	3
2	Hardware Setup	3
3	Instrument Configuration.....	4
	Overview	4
	Reference and Synchronization Source.....	4
	External Reference and Trigger Signal	7
	Signal Set-up and Phase Adjustment	7
4	Summary	9
5	Ordering Information	9

The R&S logo, Rohde & Schwarz and R&S are registered trademarks of Rohde & Schwarz GmbH & Co. KG and their subsidiaries.

1 Overview

The R&S AM300 is a dual-channel arbitrary-/function signal generator. It offers powerful functionality and spectral purity at a favorable price. The two output channels of the instrument are phase-coupled, thus it can generate two signals with precisely defined time and phase relationship. However, some applications require more than two signals with a defined phase relationship. This can be implemented by connecting several AM300 together as the AM300 provides output connectors for both, the reference signal and the synchronization signal at the rear of the instrument. This application sheet describes the set-up and configuration of two AM300.

2 Hardware Setup

Figure 1 shows the cable connection of two AM300. The first AM300 is used as the reference and synchronization source. Connect the '10MHz Out' port of the first AM300 with the '10MHz In' port of the second AM300 and connect the 'Sync. A Out' port of the first AM300 with the 'Trig/Gate In' port of the second AM300.

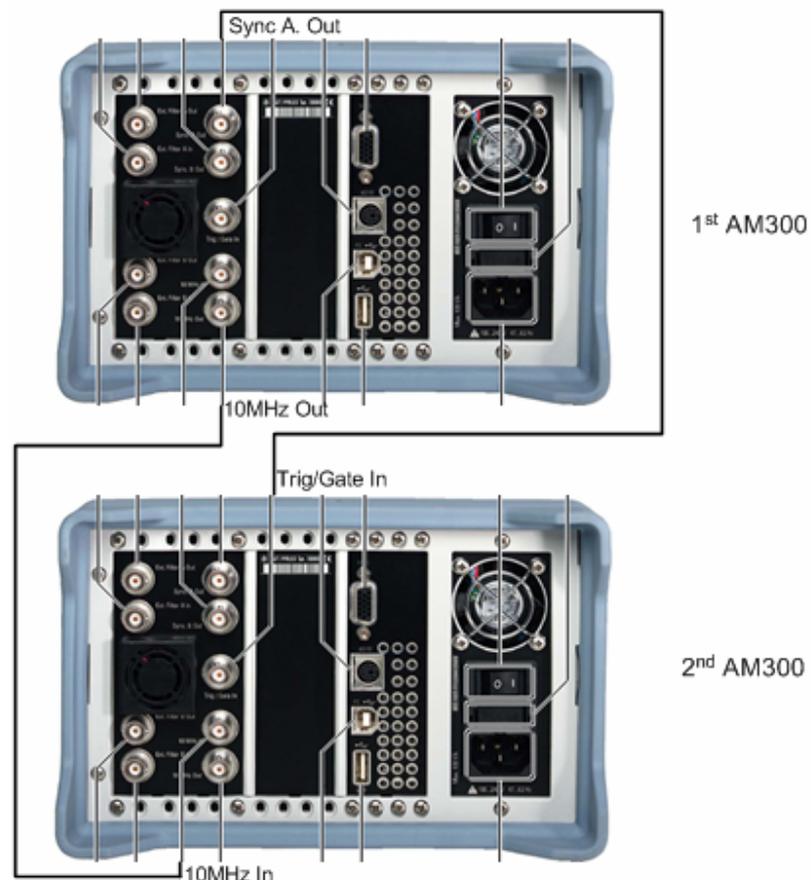


Figure 1: Hardware setup to synchronize two AM300

Two AM300 can generate up to four signals. If more than four signals are needed, a third or more AM300 are required. They should be connected in the same way as the second AM300.

3 Instrument Configuration

Overview

The instrument configuration is done in three main steps:

1. One generator AM300 has to be configured to act as a reference and synchronization source ('first AM300').
2. The other AM300 has to be configured for an external reference and trigger signal ('second AM300').
3. Finally the signal set-up for channel 1 and 2 of both AM300 has to be programmed, and a phase adjustment between the signals, generated by the first AM300 and the second AM300, needs to be carried out.

Step 3 requires an Oscilloscope to measure the phase difference between the first and second generator. This oscilloscope can also be used to verify the final signals on all four channels after phase adjustment.

Reference and Synchronization Source

After the hardware set-up of both AM300, the first AM300 needs to be configured as synchronization source. Two internal synchronisation signals can be selected:

- Comparator
- Main accumulator.

Comparator

The synchronization signal is generated by analog comparators. The switching threshold is fixed at the zero crossing. The comparator signals deliver relatively jitter-free output signals across the whole frequency range.

Main accumulator

At low frequencies it might be advantageous to select the synchronisation signal generated from the most significant bit (MSB) of the main phase accumulator ('Main accu'). As in the case of the comparators the switching threshold is at the zero crossing at 0° and 180°. Since the start phase is added on only after the phase accumulator there is a phase difference between the output signal and the synchronization signal.

Selection of the Synchronisation signal

1. In the **CH1** menu press the **OUTPUT** function key.
2. In the **OUTPUT** submenu press the **SYNC** function key.
3. In the **SYNC** submenu press the **SYNC SOURCE** function key.
4. A selection field, containing specified settings, is displayed.



The default setting is 'Comparator'.

5. Either use the default setting or use the rotary knob to select 'Main Accu'.
6. Press the ENTER key to close the selection field.

Phase delay

When the second AM300 signal is triggered, there will be a delay of the activation time. Thus the two different kinds of synchronization sources will cause different phase delays due to the different delay time of the trigger signal in relation to the function signal. Figure 2 to Figure 5 show the CH1 output synchronization signal with the to different synchronization sources versus the CH1 output sine wave at two different frequencies.

The pink color waveform is the synchronization signal, while the yellow one is the CH1 signal. With 'Main Accu' as synchronization source the trigger is always ahead of the CH1 signal, while with 'Comparator' the trigger is always lagged. Using 'Main Accu' the phase shift increase with increasing signal frequency is larger than using 'Comparator'. As the frequency increases, the jitter of the triggered signal also will increase. In both cases the phase shift needs to be compensated with the phase setting of the triggered signal.

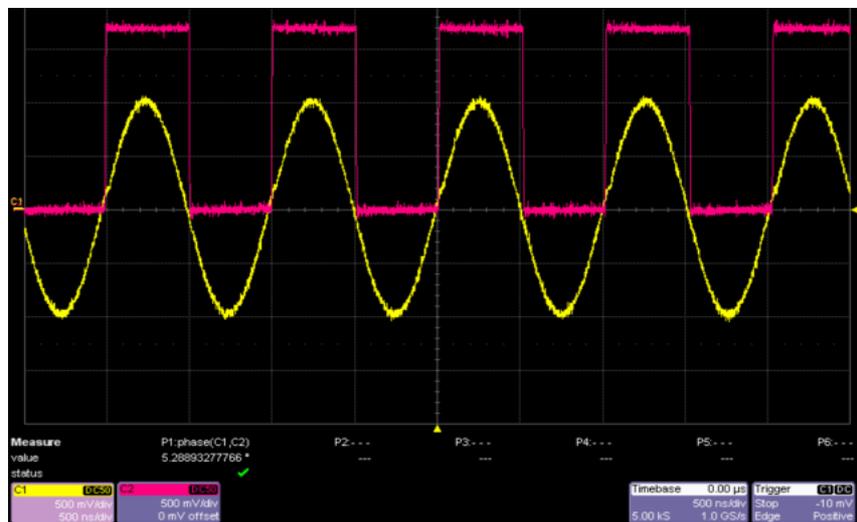


Figure 2: CH1 Sync. Source 'Comparator' vs CH1 signal at 1MHz ($\Delta\phi = 5.29^\circ$)

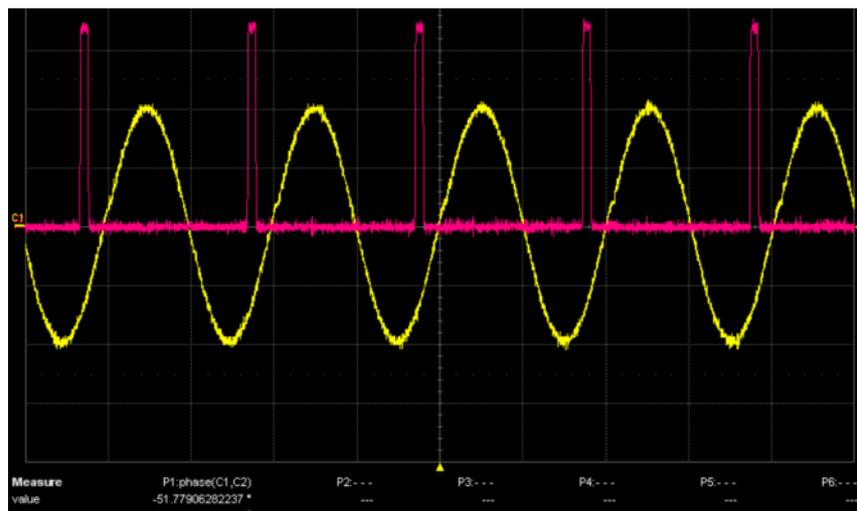


Figure 3: CH1 Sync. Source 'Main Accu' vs. CH1 signal at 1 MHz ($\Delta\phi = 51.33^\circ$)

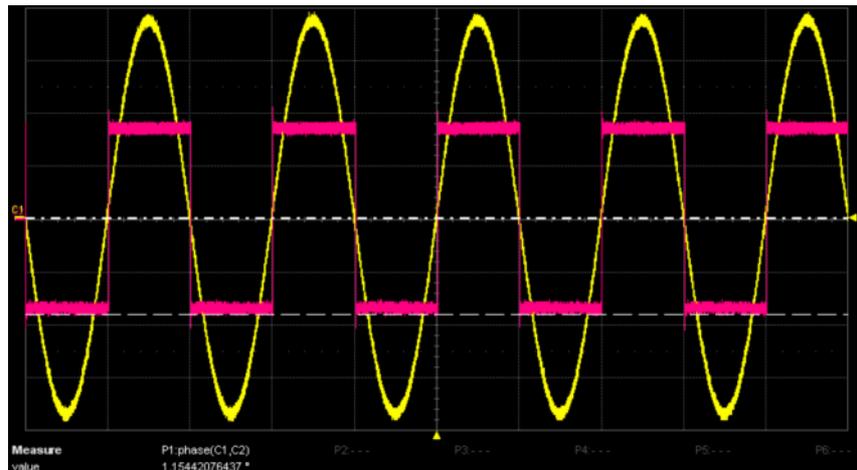


Figure 4: CH1 Sync. Source 'Comparator' vs. CH1 signal at 10KHz ($\Delta\phi = 1.15^\circ$)

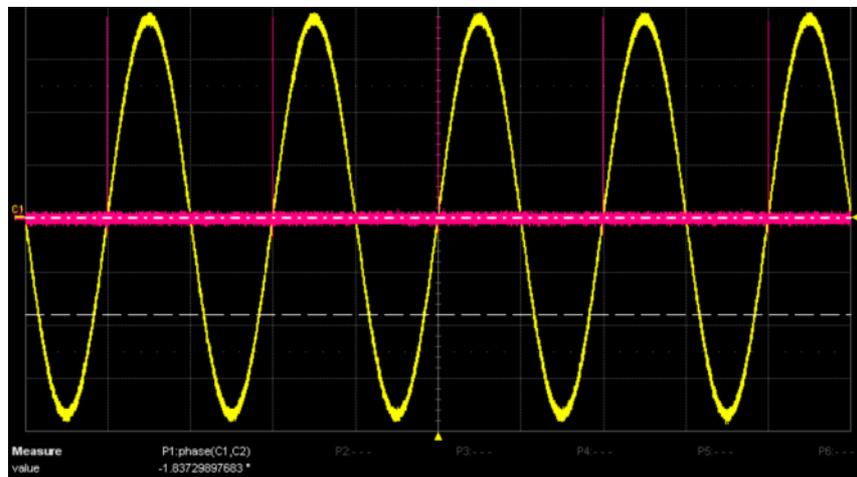


Figure 5: CH1 Sync. Source 'Main Accu' vs. CH1 signal at 10 KHz ($\Delta\phi = -1.84^\circ$)

The *trigger function* of the AM300 is provided to trigger a frequency sweep. The *Gate/Burst* function is used to trigger a waveform. Thus the *Gate/Burst* function needs to be activated in order to trigger the second AM300 continuously. The steps to configure this function are shown below.

1. Select **TRIG/GATE** menu with the ◀ or ▶ cursor key.
2. In the **TRIG/GATE** submenu press the **GATE/BURST** function key.
3. In the **GATE/BURST** submenu press the **GATE FUNCTION** function key to select the gate function. Choose **Block End**.



4. Press the **GATE LENGTH** function key to set the gate length to 9999 seconds, as we want to have a constant output signal. If an application requires a continuous output signal with duration of more than 2.8 hours (9999 s), another solution needs to be sought out.

External Reference and Trigger Signal

Now the second AM300 needs to be configured to use the external reference signal coming from the first AM300:

1. Press the **SYS** key. Preset the AM300 by pressing the **PRESET** key.
2. Select the **CONFIG** menu with the ◀ or ▶ cursor key. The menu name is highlighted and the appropriate functions are assigned to the function keys.
3. Press the **REF** function key in the menu. The current reference source setting is displayed.
4. Select the **Reference: INT/EXT** parameter. Select **External** reference source with the rotary knob. Press the **ENTER** key.

Then the second AM300 has to be programmed to be externally triggered by the first AM300. Activate the GATE function:

1. Select the **TRIG/GATE** menu with the ◀ or ▶ cursor key.
2. In the **TRIG/GATE** submenu press the **GATE/BURST** function key.
3. In the **GATE/BURST** submenu press the **GATE FUNCTION** function key to select the gate function. Choose **Block End**.
4. Press **GATE EXTERN**. Thus the signal output will be triggered only by external trigger.

After these configurations both AM300 are ready to output phase-synchronized signals by configuring the **CH1** and **CH2** menu.

Signal Set-up and Phase Adjustment

As an example four sine wave signals with different phase at 0°, 90°, 180° and 270° respectively shall be generated. CH1 and CH2 of the first AM300 will be configured to output the signals with phase 0° and 90°, while CH1 and CH2 of the second AM300 will be configured to output the signals with phase 180° and 270°.

After connecting and configuring both AM300 as described above the remaining steps are given in the following description.

Settings for the first AM300:

1. Press **CH1** Menu.
2. Press the **FREQ** key to configure the frequency.
3. Press the **AMPT** key and in the submenu; press **Vpp** to configure the signal peak to peak value.
4. Press the **WAVEFORM** key to choose **SINE**.
5. Activate CH1 by pressing the **CH1 ON** key. Once it is on, the color of the key will be blue.
6. Press **CH2** Menu.
7. Repeat step 2 to 4 in **CH2** submenu.

8. Press the **WAVE PARAM** key, and in the submenu press the **START PHASE** key and key in the 90°.
9. Activate CH2 by pressing the **CH2 ON** key

Settings for the second AM300:

1. Press **CH1** Menu.
2. Press the **FREQ** key to configure the frequency.
3. Press the **AMP** key, and in the submenu press **Vpp** to configure the signal peak to peak value.
4. Press the **WAVEFORM** key to choose **SINE**.
5. Activate CH1 by pressing the **CH1 ON** key. Once it is on, the color of the key will be blue.

Phase adjustment

After doing these configurations we need to do a phase adjustment caused by the phase shift of the synchronization signal and the triggering time of the second AM300. This can be done by using an oscilloscope. An example is shown in Figure 6. The signal frequency is 1 MHz. The yellow waveform is the CH1 signal of the first AM300, while the pink waveform is the CH1 signal of the second AM300. The measured mean value $\Delta\phi_{\text{mean}}$ of the phase difference between both signals is around 2°.

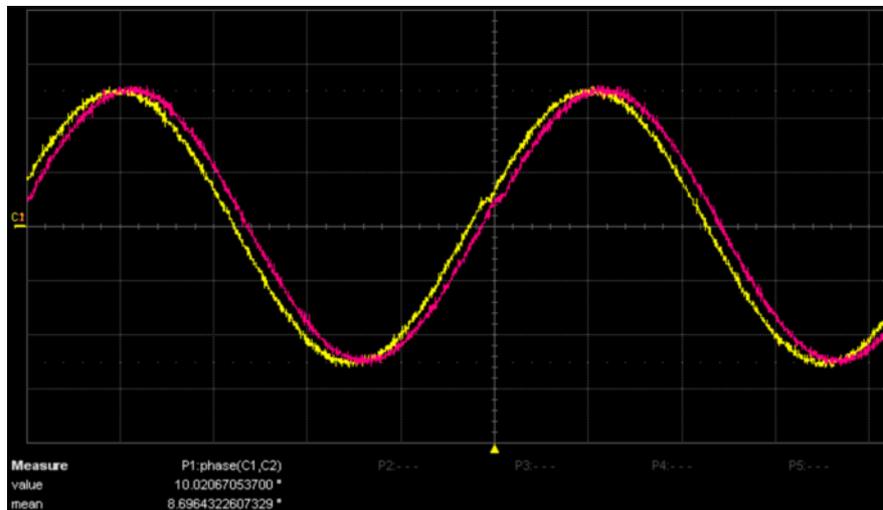


Figure 6: Phase shift of the two signals at $f = 1\text{MHz}$ ($\Delta\phi_{\text{mean}}=8.6^\circ$).

6. Press the **WAVE PARAM** key, and in the submenu press the **START PHASE** key. The phase should be $-180^\circ + \Delta\phi_{\text{mean}}$ (the input range of the phase is -180° to 180°).
7. Press **CH2** Menu.
8. Repeat step 2 to 4 in **CH2** submenu.

9. Press the  key, and in the submenu press the  key. The phase should be $-90^\circ + \Delta\varphi_{\text{mean}}$.
10. Activate CH2 by pressing  key.

Using the oscilloscope you can then see all four waveforms.

The phase compensation is fixed at the particular frequency. So, you don't have to measure the phase delay all the time.

4 Summary

Using more than one AM300 multi phase synchronized signals can be generated. This application sheet demonstrates how to do the setup and how to compensate the phase shift due to the delay of the synchronization signal and the triggering time.

For comments and suggestions please contact

customersupport.asia@rohde-schwarz.com.

5 Ordering Information

Type of instrument

R&S AM300	Dual Channel Arbitrary / Function generator	1147.1998.03
R&S AM300-K3	SW-Option: WinIQSim	1406.4008.02
R&S AM300-Kx	SW-Option: Digital standard on request, AM300-K3 required	



ROHDE & SCHWARZ

<http://www.rohde-schwarz.com>

This Application Note and the supplied programs may be used only in accordance with the conditions of use set forth in the download area of the Rohde & Schwarz website.