

Experiment 2 - An introduction to the Telecoms-Trainer 101

Preliminary discussion

As its name implies, the Emona Telecoms-Trainer 101 is used to help people learn about communications and telecommunications principles. It lets you bring to life the block diagrams that fill communications textbooks. A "block diagram" is a simplified representation of a more complex circuit. An example is shown in Figure 1 below.

Block diagrams are used to explain the principle of operation of electronic systems (like a radio transmitter for example) without worrying about how the circuit works. Each block represents a part of the circuit that performs a separate task and is named according to what it does. Examples of common blocks in communications equipment include the *adder*, *filter*, *phase shifter* and so on.

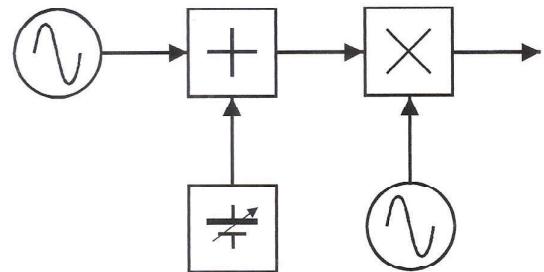


Figure 1

The Emona Telecoms-Trainer 101 has a collection of blocks (called *modules*) that you can put together to implement dozens of communications and telecommunications block diagrams.

The experiment

This experiment is in three stand-alone parts (2-1, 2-2 and 2-3) and each introduces you to one or more of the trainer's analog modules.

It should take you about 1 hour to complete 2.1 of this experiment, about 50 minutes to complete 2.2 and about 1 hour to complete 2.3.

Equipment

- Emona Telecoms-Trainer 101 (plus power-pack)
- Dual channel 20MHz oscilloscope
- two Emona Telecoms-Trainer 101 oscilloscope leads
- assorted Emona Telecoms-Trainer 101 patch leads
- **For 2.1 only** - one set of headphones (stereo)

Some things you need to know for the experiment

This box contains definitions for some electrical terms used in this experiment.

Although you've probably seen them before, it's worth taking a minute to read them to check your understanding.

Two signals that are **in phase** with each other are synchronised. That is, they go up and down at the same time.

Two signals that **out of phase** are not synchronised. That is, they are out of step with each other. An example of two signals that are out of phase is shown in Figure 3 below.

Phase difference describes how much two signals are out of phase and is measured in degrees (like degrees in a circle). Signals that are in phase have a phase difference of 0° . Signals that are out of phase have a phase difference $> 0^\circ$ but $< 360^\circ$.

A **sinewave** is a repetitive signal with the shape shown in Figure 1.

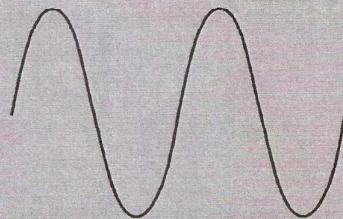


Figure 2

A **cosine wave** is simply a sinewave that is out of phase with another sinewave by exactly 90° . A sinewave and a cosine wave are shown in Figure 3. (They're not marked because, in this case, it doesn't matter which one is which.)

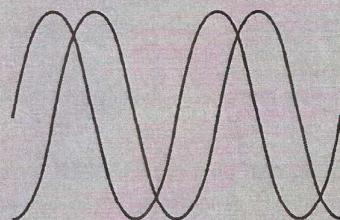


Figure 3

2.1 - The Master Signals, Speech and Buffer modules

The Master Signals module

The Master Signals module is an AC signal generator or oscillator. The module has six outputs providing the following:

Analog

- A 2kHz sinewave
- A 100kHz sinewave
- A 100kHz cosine wave

Digital

- A 2.083kHz squarewave
- An 8.33kHz squarewave
- A 100kHz squarewave

Each signal is available on a socket on the module's faceplate that's labelled accordingly.

Procedure

1. Gather a set of the equipment listed on page 2-2.
2. Connect the set-up shown in Figure 1 below.

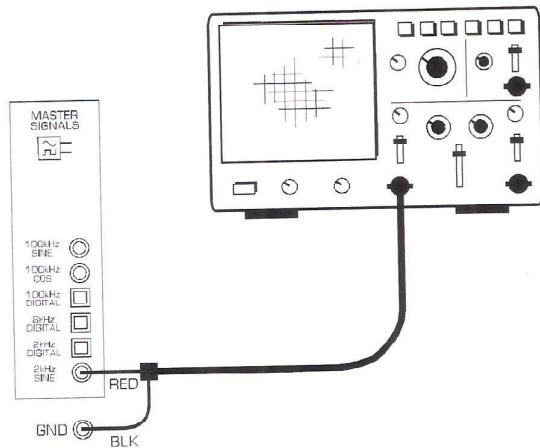


Figure 1

This set-up can be represented by the block diagram in Figure 2 below.

Master signals

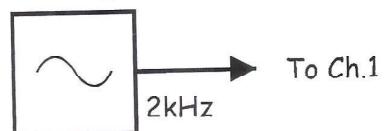


Figure 2

3. Set up the scope per the instructions in Experiment 1. Ensure that:
 - the *Trigger Source* control is set to the *CH1* (or *INT*) position.
 - the *Mode* control is set to the *CH1* position.
4. Adjust the scope's *Timebase* control to view two or so cycles of the Master Signals module's *2kHz SINE* output.
5. Measure the amplitude (peak-to-peak) of the Master Signals module's *2kHz SINE* output. Record your measurement in Table 1 below.
Tip: If you're not sure how to measure the signal's amplitude, see Experiment 1 (page 1-6).
6. Measure and record the period of the Master Signals module's *2kHz SINE* output.
Tip: If you're not sure how to measure the signal's period, see Experiment 1 (page 1-7).
7. Use the period to calculate and record the frequency of the Master Signals module's *2kHz SINE* output.
Tip: If you're not sure how to calculate the signal's frequency, see Experiment 1 (page 1-8).
8. Repeat Steps 4 to 7 for the Master Signals module's other two analog outputs.

| Table 1 | Output voltage | Period | Frequency |
|-------------|----------------|--------|-----------|
| 2kHz SINE | | | |
| 100kHz COS | | | |
| 100kHz SINE | | | |



Ask the instructor to check
your work before continuing.

It is critical to the operation of several communications and telecommunications systems that there be two (or more) sinewaves that are the same frequency but out of phase with each other. Figure 3 below shows examples of pairs of sinewaves that are out of phase by different amounts.

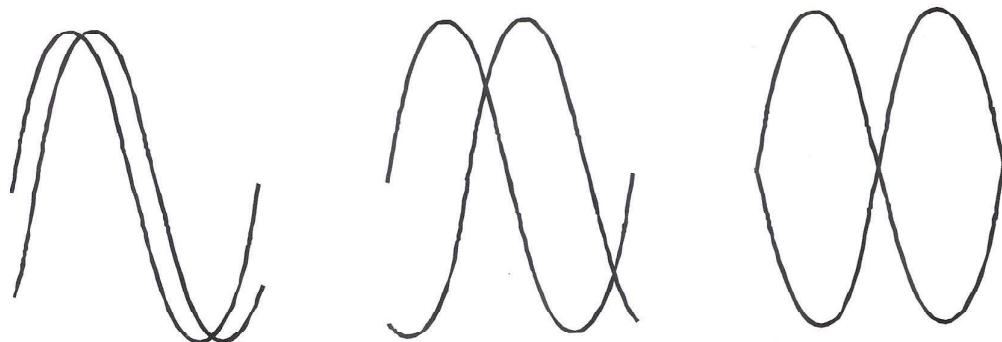


Figure 3

It's a useful skill in communications and telecommunications to be able to measure the phase difference between signals. The next part of the experiment gives you practise at this by getting you to measure the phase difference between the Master Signals module's 100kHz *SINE* and *COSINE* outputs.

9. Connect the set-up shown in Figure 4 below.

Note: Insert the black plugs of the oscilloscope leads into a ground (*GND*) socket.

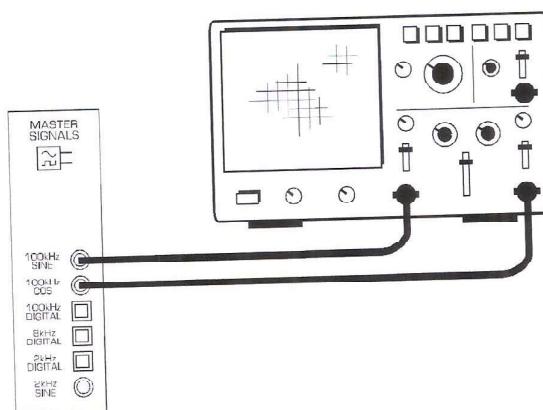


Figure 4

The following procedure can be used whenever you need to measure the phase difference between two signals.

10. Set the scope's *Mode* control to the *Dual* position to view both of the Master Signals module's 100kHz outputs.
11. Adjust the scope's *Timebase* control to view as few **complete** cycles of the two signals as possible.
12. Set the *Input Coupling* controls for both channels to the *GND* position.
13. Use the *Vertical Position* control of both channels to align both traces with the horizontal line in the middle of the scope's display.
14. Set the *Input Coupling* control for Channel 1 to the *AC* position.
15. As accurately as you can, count the number of divisions for one cycle of the signal. Call this dimension the "period".

Record your measurement here: Period =

16. Set the *Input Coupling* control for Channel 2 to the *AC* position.

17. As accurately as you can, count the number of divisions between the two signals as shown in Figure 5.

Call this dimension the "difference" and record your measurement here:

Difference =

Tip: The sub-divisions on the scope's display are each worth 0.2 of a division.

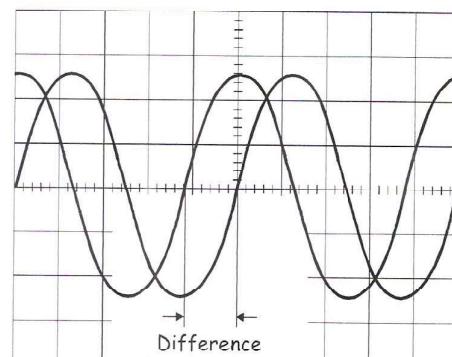


Figure 5

18. Use the equation below to calculate the phase difference between the two signals. Record the answer to your calculation in Table 2 (on the next page).

$$\Phi \text{ difference} = \frac{\text{difference}}{\text{period}} \times 360^\circ$$

Table 2

| Φ difference between the SINE and COS outputs | |
|--|--|
| | |

Question 1

The theoretical phase shift between a sinewave and a cosine wave is 90° . If your measurement isn't exactly 90° , what could explain the difference?



Ask the instructor to check
your work before continuing.

The Speech module

Sinewaves are important to communications. They're used extensively for the *carrier signal* in many communications systems. Sinewaves also make excellent test signals. However, the purpose of most communications equipment is the transmission of speech (among other things) and so it's useful to examine the operation of equipment using signals generated by speech instead of sinewaves. The Emona Telecoms-Trainer 101 allows you to do this using the Speech module.

19. Set the scope's *Mode* control to the *CH1* position.
20. Set the scope's *Timebase* control to the *2ms/div* position.
21. Connect the set-up shown in Figure 6 below.

Note: Insert the oscilloscope lead's black plug into a ground (*GND*) socket.

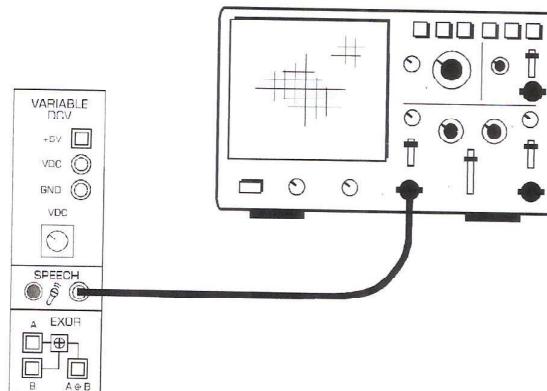


Figure 6

22. Talk into the microphone while watching the scope's display. Be sure to say "one" and "two" several times. Try humming and whistling too.



Ask the instructor to check
your work before continuing.