KUSTOM SIGNALS, INC.®

Eagle 3 eFork™ Electronic Tuning Fork with Advanced Fork Test

12/4/2020

Overview

Kustom Signals has long recommended testing traffic RADAR with tuning forks as described in the appropriate RADAR operator's manual at the beginning and end of each shift. The tuning fork test ties together the internal self-tests and patrol speed tests and completes the testing path. The tuning fork signal travels through the entire RADAR system signal path and the frequency of the tuning fork is accurate enough to verify the RADAR system's specified tolerance.

In recent years, there has been industry discussion whether the tuning fork test could be eliminated from daily test procedures. There are two issues with eliminating the tuning fork tests:

1. The Tuning fork test has been an accepted legal standard and case law recognized in many U.S. states dating back to 1966 with *State v. Tomanelli 1966 152 Conn 365, 216 A2d 625*.

2. The combination of the appropriate internal self-test and officer's comparison to the vehicle speedometer can be very effective in determining the general accuracy of the RADAR system. But this method may not test the RADAR to the specified accuracy of ±1 MPH (+1/-2 km/h), which has historically only been possible with a certified tuning fork.

The Issues

There are several issues with managing RADAR tuning forks. They often go home in duty bags, they get lost, they ring differently with temperature extremes, and it can take a lot of time to conduct a proper tuning fork test in stationary and moving modes on two antennas. The time spent each day conducting tuning fork tests can be extensive – especially in states and municipalities that require a fork test with each speeding citation!

The *Eagle 3* eFork Solution and FAQs

The ***Eagle 3*** electronic tuning fork along with the Advanced Fork Test conducts a comprehensive test on two antennas in less than 20 seconds. The ***Eagle 3*** prompts the user to ring two fork frequencies on both antennas, providing a clear pass/fail message. Optionally, the ***Eagle 3*** can require the user to conduct a successful fork test before placing the RADAR system into service.

Figure 1 - *Eagle 3* Remote Control Electronic Fork Test with Pass LED Indicator

How is the *Eagle 3* electronic fork the same and how is it different than ringing a traditional tuning fork?

The ***Eagle 3*** remote control with electronic tuning fork uses a crystal based oscillator and a microwave mixing diode to produce a very precise and stable electronic signal like that of a traditional tuning fork. The RADAR sees no difference between the two methods and either the electronic fork or a traditional mechanical tuning fork may be used to test the ***Eagle 3*** RADAR. A traditional fork rings at a particular frequency that the RADAR processes as a Doppler shift. A tuning fork is not ringing at 35 MPH, otherwise you could use the same fork to test a K-band or a KA-band RADAR antenna. When you ring a tuning fork, the fork oscillates at a particular frequency that is seen by the RADAR as a Doppler shift for a particular speed for the particular frequency band of operation by the RADAR antennas.

The ***Eagle 3*** remote control produces the same type of signal which is oscillating at a particular frequency that is processed by the RADAR as a Doppler shift. A very nice benefit of the ***Eagle 3*** electronic fork signal is that it produces a more consistent signal. For example, when you ring a fork too hard, you can produce harmonics which can result in bad speeds during the fork test. A traditional fork also dampens over time (the fork stops ringing.) The oscillator in the ***Eagle 3*** remote produces a consistent signal that doesn't change with time or temperature and it does not produce harmonics.

How is the *Eagle 3* electronic fork feature more accurate than ringing a mechanical fork, and why?

The ***Eagle 3*** remote control is using a quartz crystal as a time base. One benefit is that there is little to no movement of the frequency due to temperature extremes. That is not the case for a traditional fork which

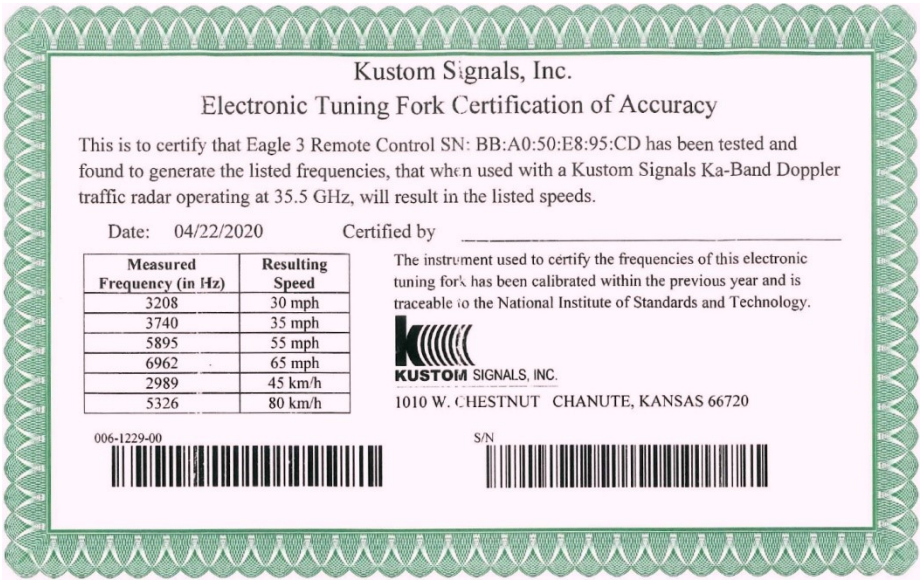
can fluctuate greatly due to low or high temperatures. The electronic fork signal tolerance is also much tighter than a traditional tuning fork. That means that the electronic fork is more accurate and does not vary with temperature or time.

How is the *Eagle 3* Remote Control easier to certify than a traditional fork?

When certifying a mechanical tuning fork, a Service Technician uses a microphone, an amplifier, and a frequency counter to conduct the test. The microphone and the amplifier are taking the acoustical signal produced by ringing the tuning fork and transforming it into an electrical signal that is measured with the frequency counter.

The ***Eagle 3*** electronic fork is producing the same electronic signals which do not need to be transformed in order for the frequency counter to analyze them. Again, the mic & amp take an acoustically signal (fork ring) and transform it into an electrical signal. The electronic fork is already an electrical signal and does not require transformation. Therefore certifying our electronic fork is actually much easier than a traditional fork.

To certify an ***Eagle 3*** remote control, you can eliminate the microphone and the amplifier and test the electric fork signal direct with the frequency counter. Each remote control has a unique serial number and can be certified just like a tuning fork.



Kustom Signals, Inc.

Electronic Tuning Fork Certification of Accuracy

This is to certify that Eagle 3 Remote Control SN: BB:A0:50:E8:95:CD has been tested and found to generate the listed frequencies, that when used with a Kustom Signals Ka-Band Doppler traffic radar operating at 35.5 GHz, will result in the listed speeds.

Date: 04/22/2020 Certified by _____

Measured Frequency (in Hz)	Resulting Speed
3208	30 mph
3740	35 mph
5895	55 mph
6962	65 mph
2989	45 km/h
5326	80 km/h

The instrument used to certify the frequencies of this electronic tuning fork has been calibrated within the previous year and is traceable to the National Institute of Standards and Technology.

KUSTOM SIGNALS, INC.

1010 W. CHESTNUT CHANUTE, KANSAS 66720

006-1229-00

S/N

Figure 2 - *Eagle 3* Remote Control Electronic Fork Certificate

Conclusion

The ***Eagle 3*** electronic tuning fork along with the Advanced Fork Test procedure is a revolutionary new way to comprehensively and quickly test your RADAR system. Additionally, the ***Eagle 3*** remote control

has been tested and proven to meet or exceed the frequency and speed accuracy specifications required to certify mechanical tuning forks.

Institute of Police Technology and Management

University of North Florida

Eagle 3 Electronic tuning fork Ka band, S/N BB:A0:50:E8:65:A6

Manufacturer: Kustom Signals, Inc.
1010 W. Chestnut, Chanute, Kansas 66720

This certificate confirms that the electronic tuning fork signals met or exceeded the frequency and speed accuracy specifications required for radar mechanical tuning fork certifications. This functionality is optionally included in the Eagle3 Radar system, which is listed on the NHTSA Conforming Product List.

The type and extent of testing and test results were reported in Test Report Number 2020_01 KSI ETF.

16 August 2020

UNF UNIVERSITY of NORTH FLORIDA.

Chiu Choi, Ph.D., P.E.

Figure 3 - Eagle 3 Electronic Tuning Fork Lab Certification