eSCOPE®
Electronic Lab Scope
Training

Common questions asked about scope speed

What scope is better? Better is a relative term that depends on who is using the scope. A low end scope that is used effectively by someone is better for them than a much more powerful scope they can't use effectively.
This is true, any scope that can display waveforms is better than no scope at all. However, many scopes that are in use for automotive repair, high or low end, have some problems with dropping data. A scope can only display what was captured within the memory system. This means that if the drivability problem you are looking for causes the vehicle to fail when the scope buffer drops the data then no failure will be shown on the scope display. This can be especially frustrating with an intermittent failure that requires extensive driving to duplicate. This is a problem when using scopes on vehicles as most scopes were not designed to never drop data. Technicians using scopes at places such as Intel or Siemens are not as
concerned with data loss. They are more concerned with a very high speed acquisition rate so they can see high speed electronic signals when designing or repairing electronic systems. When looking at these very high speed electronics the data buffers are over driven quickly causing data losses.

What is aliasing and when does it occur?
Aliasing is basically a form of under sampling the signal so what is displayed on the scope is not an accurate representation of the waveform being acquired. Aliasing from under sampling is not the only cause of an inaccurately displayed signal. Any time the frequency of the signal that is being acquired by the scope is not close enough to the frequency set within the scope, an inaccurate representation of the waveform will be displayed. This occurs when the scope is set too fast for the signal or when the scope is set too slow for the signal. One such example can be seen when a faster automotive signal, such as an injector, is set with the slower time base for an oxygen sensor. In this case the injector signal will be shown coming and going, when in fact the injector was turned on and off each and every time. With any scope it will be important to match the frequency of the signal being acquired with the frequency of the scope. This is why high speed scopes are not fully utilized in the automotive industry. Automotive electronics are slow compared to that of the electronic industry. Since the scope sampling speed must match the acquired signal the speed of the scope must be set to a slower sampling speed. This allows the waveform to be constructed so that it represents the waveform accurately. A scope that can run at 100 mega samples per second cannot be run at full speed for 99% of the signals that will be diagnosed on the vehicle. One such example is using a Formula 1 car for driving around town. The vehicle would not work properly for the conditions that
it is working in, it would have problems like the engine overheating. This F1 vehicle was designed for maximum speed on a race track and not to be driven around town. It would be far better to have a new Corvette for these working conditions. Even through the Corvette is slower than that of the F1 car it will work far better in the driving conditions around town such as during rush hour traffic. It is always important to match the scope with that of the working conditions of the signals being
acquired.

What is the maximum sample rate of the best ATS scope?
The fastest scope that ATS produces is the eSCOPE HIGH SPEED and runs up to 50 mega samples per second. However, this is not the best scope ATS makes for the automotive industry. The best scope for this is the eSCOPE PRO or the eSCOPE ELITE4, and these scopes both have a 1 mega sample per second throughput. The circular buffer that ATS uses in their scopes prevents overdriving of the data buffer assuring that no data is ever dropped. This means that the data moving in and out of the circular buffer occurs at the same rate so no data is ever lost. The sample rate is just one of the 2 most important features that the Analog-to-Digital Converter (ADC) uses to acquire signals. The vertical resolution is also being transmitted to the display from the ADC. Most other scopes used in the automotive field use 8 bit ADCs. This allows the vertical resolution to be divided by 256 discrete levels. Some scopes use 12 bits, allowing 4,096 discrete levels. The ATS eSCOPE PRO and eSCOPE ELITE4 use 16 bits which allowing 65,536 discrete levels on the vertical resolution. These discrete levels allow you to see very small voltage levels while having your voltage set to a range wide enough to capture the different types of signals on a vehicle.

1) 8 bit = 256 discrete levels, @ 40V = 156.25mV/bit
2) 10 bit = 1,024 discrete levels, @ 40V = 25.6mV/bit
3) 12 bit = 4,096 discrete levels, @ 40V = 9.76mV/bit

4) 14 bit = 16,384 discrete levels, @ 40V = 2.44mV/bit
5) 16 bit = 65,536 discrete levels, @ 40V = .61mV/bit

Note: 40 volt span = -20V to +20V, 20V being typical of automotive scope use. This is very useful when working on a vehicle. For instance if you are using an 8 bit ADC set at + - 20 volts with a pressure transducer that has 1mv = 1 PSI and you are looking at the in-cylinder pressure waveform, you would have to have more than 156 mv (156PSI) change in order for the scope to show this. So if the engine is idling the pressure transducer voltage output could not be seen, there would not be a signal that would represent the in-cylinder waveform. Even if the same scope was set at + - 1 volt the resolution would still only be 7.8mV/bit, which would still not provide adequate resolution for this signal. Yet another example, if you are driving the vehicle and the engine intermittently cuts out, with a 16 bit ADC scope you can look at the voltage signals or ground signals from other signals that you are on and see if the coils were turned on or not. This is accomplished by the voltage drops that occur from the current being supplied to the ignition coils. This current creates a voltage drop that can be seen on the powers or grounds but this cannot be done with limited bits which provide less resolution. Additionally, ATS scopes have circuit connection detection which allows you to know if you are properly connected to the circuit and the basic resistance of the circuit. Have you ever seen '0 Volts' and wondered if that was the actual circuit state, or if it was really due to a poor test connection? We have, which is why the eSCOPE applies a negative bias voltage to each channel. When you see '0 Volts, you know that your leads are connected properly…and there really is no voltage!

There are more powerful, faster scopes available, right?
This is true, but power can be defined differently depending on what the scopes intended use is going to be. If you are using the scope to look at a high speed electronic signals, such as in the Intel or Siemens environment, then speed is key. However when using a scope on vehicles the signals are quite slow, so It becomes more important to not drop any data for the signal on the vehicle. If you drive a vehicle for a long period of time in order to locate an intermittent problem the data loss can create a serious problem for the user. If the vehicle has a problem,such as a quick cut out, and the scope does not display the problem you would be sure that the circuit you were watching was not the problem. You would then move the
scope leads to other circuits to try to find the problem. Hours later you would move the scope leads back to where you started from only to find that you had missed the circuit that was failing. It is important to understand that what happened was caused by over driving the scope buffers and dropping data, which is what happens when high speed scopes are used in the automotive field. Data loss Problems can also occur when a trigger is used. The scope trigger is set at a voltage and edge (rising or falling). For example, if the vehicle's computer driver fails the voltage on the circuit under test would not change, thus the voltage would not break the set trigger threshold. This means the scope would not provide additional
data until the trigger voltage setting was crossed again. You need to understand what happens to the waveform on the screen. The last scope sweep that produced a waveform will remain on the scope display until the trigger voltage is crossed again. This means the waveform stays on the scope display. When intermittent problems occur the scope can hide the failure when using a trigger. ATS scopes are designed with this in mind. No data is ever dropped with the ATS eSCOPE PRO or the ATS eSCOPE ELITE4. With the ATS dual time base having two scope screens, one screen can be in trigger mode while the second screen can be in strip chart mode. This provides you with the best of both worlds. A trigger setting to stabilize the waveform, while the second scope screen provides no data loss so that if it fails intermittently you will
see it fail on the strip chart screen. Only ATS scopes have this feature. It is hard enough to diagnose the modern vehicle without questioning your equipment.

Furthermore some faster scopes that are used in the automotive industries have the problem of electrical noise riding on the signals from the vehicle. In order to solve the scope noise problem, the scope filters this noise off the signal. While the filter can remove nearly all the noise, it can filter out the very problem you are looking for as well. For instance when the ignition spark is loaded this can induct the spark signal on other electrical signals, like the crank or cam signals. Since the on-board computer monitors the rising and falling edges of these signals it will calculate this induction line from the ignition spark. Now the on-board computer gets out of sync with the engine, this in turn creates a drivability problem. If this ignition
spark line is filtered off of the signal on your scope you would not even know that this has occurred. ATS understands this and designs our scopes so the signal is accurate and clean. On the ATS eSCOPE PRO or the ATS eSCOPE ELITE4 no filter is needed nor recommended. Again, it is hard enough to diagnose vehicles without doubting your scope.

Once again the power of a scope can be defined differently such as, scope power is being able to watch two different frequencies at the same time and with dual time bases the job gets much easier. The ATS eSCOPE PRO or The ATS eSCOPE ELITE4 both have dual time bases, allowing the user to use 2 time bases and trigger modes at the same time. This is basically 2 scopes in 1, allowing one scope to have a trigger set for the stabilization of the waveform while strip charting the second scope so no failure is missed. This is extremely helpful on a vehicle because you can watch faster signals on one display, such as; ignition, injectors, CKP, CMP, etc. and slower signal on a second display, such as; O2, WRAF, MAF, TPS, APPS, etc. This allows you to see the ignition coil fail and see the O2 blast on the O2 sensor in real time. The ATS scopes also have function generators to simulate vehicle sensor signals and a power sync so you can

turn on components such as ignition coils and fuel injectors. Again, the power of the scope is directly related to the intended use.

Ease of use also has to be considered for the power of a scope as well. No time, voltage, or trigger setup is needed with the powerful Deep Record function, you can grab a large amount of data without any setup at all. Then simply zoom in to see what happened! Apply filtering, turn signals on/off, and rearrange waveforms as you wish. Saved files can be reopened and manipulated in the same way at any time. No other Lab Scope offers this 'after the fact' flexibility, and it's the favorite feature for most users. The number of channels to acquire data for the vehicles needs to be considered here as well. One such
example would be if you were looking at scan tool data and you choose 2 PIDs. This would make it very difficult to see what the system as a whole is doing. In order to understand the system's problem you would choose at least 8 PIDs. This would allow you to see what the system is doing as a whole. Thus, making it much easier to diagnose the vehicle. If you would not choose 2 or 4 PIDs with your scan tool to diagnose the vehicle on a problem vehicle, why would you only choose 2 to 4 channels on your scope? The ATS eSCOPE PRO has 8 channels because ATS does not limit the user but strives to empower you, the user.

What is the baud rate of high speed CAN? (baud rate is the frequency of the shortest one bit pulse).
The Control Area Network (CAN) is a standard set by the SAE and ISO for the networking of vehicles. CAN comes in several different networking speeds such as;

CLASS A – LOW SPEED (<10KB/S) MAXIMUM MESSAGE RATE IS ABOUT 100MS OR LESS THAN 10 MESSAGES PER SECOND;

CLASS B –MEDIUM SPEED (10 TO 125 KB/S) MAXIMUM MESSAGE RATE IS ABOUT 20MS OR LESS THAN 50 MESSAGES PER SECOND;

CLASS C – HIGH SPEED (125KB/S TO 1MB/S) MAXIMUM MESSAGE RATE IS <5MS OR LESS THAN 200 MESSAGES PER SECOND.

In each of the CAN speeds the bit length will be different. The CAN transceiver is designed to allow the user to set what the bit rate for the messages will be, thus changing the bit length. So what this means is that the 1 mega sample rate will not be able to display each individual bit on the CAN high speed system. However, this 1 mega sample per second rate will be able to display the message packets. The bit wise message set on a CAN bus is priority to the manufacture. This means that even if you can determine each of the bits you still cannot decode the message. Furthermore, if you can see the message and the bits within the message this does not mean you can keep up with all the message packets on the bus. Most scopes buffers are over driven and can only get a small sample of what messages are currently on the bus. This means that you may not see the failure when it occurs. It will be far more important to be able to strip chart the messages in their packet form. This way you can see each packet on the bus. If the voltage on the packet fails you will be able to clearly see this thus, you can see all the messages on the bus and then determine if the voltage levels are failing or not. The scan tool is programed to understand each bit within the message that is sent on the CAN bus. This is a much better way to decode CAN messages and find problems quickly on the CAN system. The scope is used to check the basic voltages on the communication bus and to see if and when they fail.

So the ATS scopes are not fast enough to see high speed CAN?
This is not the case. ATS's 1 mega sample per second rate is more than fast enough to display CAN message packets. These packets and the voltage levels that they ride on is what you need to diagnose the CAN system. Even if you get the bits within the message you will be unable to decode what the message is. These messages are proprietary to the manufacture. If you could just get the CAN message and decode it, then every scan tool made would be a factory level scan tool, which you know this is not the case.

To actually understand what is best for the automotive market and not Intel, it is very important to properly understand what you are using the scope for; designing Intel circuits or fixing the modern automobile in your shop.

Don't be fooled by scope speed. It is just one piece of a much bigger picture.