Radar Detection Testing Methodology & Best Practices

ESCORT REDLINE 360c

Contents

Abstract

Rigorous testing is a cornerstone of software and product development. The standardization of these methods and procedures can greatly improve data aggregation for quantifying performance while empowering better troubleshooting by identifying potential anomalies.

Since methods may vary between manufacturers, the purpose of this paper is to define Escort Radar's approach and methodology in our testing. As a side note, some of these testing methods can be replicated easily by other testers in the field while some require dedicated lab equipment.

With the release of our new firmware update, we believe that new and existing Redline 360c users can expect superior performance that will completely renew the capabilities of their radar detector, making it even more effective in real-world use. This document exists to validate this with transparency into our testing methodologies and the corresponding data to substantiate the claims made.

Performance Benchmarking

There are typically three key performance attributes enthusiasts and consumers look for in a radar detector. Those are response time, range, and filtering (real threats vs false alerts).

Response Time

Commonly discussed by enthusiasts, response time is somewhat simple to quantify with the use of Police quick-trigger radar guns. This method involves manually pulling and releasing the trigger, documenting the speed of a vehicle. This is done with the aim of being so fast that a radar detector may not even detect it. A typical approach to measuring response times is done simply by timing from when the trigger on the radar gun is pulled to when a radar detector registers and alerts a driver to the signal. With response time less than one second, this leaves a lot of room for error in measurement.

We consider lab testing to be the most precise method for measurement of response time. We use hardware and software designed to measure at times less than one second. We also conduct a manual version of this test using people to pull the trigger on different radar guns.

Sensitivity & Range

Range testing is difficult to standardize since it involves a combination of metrics that can directly influence performance. This includes not only sensitivity and response time but also the unique environmental conditions that exist while testing (e.g. open plains vs mountains, foliage, road curvature, sun or rain, temperature, volume of traffic, etc.).

As mentioned in the Response Time section above, we also consider lab testing to be more precise for the measurement of sensitivity. We also complement the lab testing with a field test for range, where we do comprehensive range testing in an environment to what our customers drive in (long stretches of road with potential obstructions, like trees and hills). This helps provide a more valuable and relative perspective for real-world use.

False Alerts

Quantifying false alert performance is the most complicated aspect to benchmark. The layperson typically doesn't realize how prolific radar signal usage is, with X and K band both being used for sensors on automatic doors, garage doors, and other proximity sensors; and K band now heavily being used by many new vehicles for blind spot monitoring or collision avoidance systems (CAS) and lane change assist features. During one of our typical one-hour drive tests (city and highway) we typically see as many as 10,000 unique signals.

Since this radar signal "noise" is now more common, modern radar detectors must actively filter the noise, alerting the user only to valid threats on the road. Radar detector performance is heavily based upon if "real" alerts come through while eliminating the noise generated by the variety of other signals in the same bandwidth.

Testing Methodology

Performance attributes have been broken into two sections: Lab and Field (AKA real world)

Response Time

In-Lab:

This is an automated test performed with software and hardware that precisely measures response times and latencies at police-specific radar frequencies.

Equipment Used:

- HP 83640A Synthesized Sweeper
- GPIB Computer Interface
- Test Box
- Microphone & Synthesizer Control Board
- Calibrated Horn (to account for path loss)
- Computer System with Response Test Software

Radar Settings:

- Sensitivity: Highway
- Meter Mode: Spec FR1
- Bands Enabled: X, K, Ka on (Ka-Wide)
- TSR: Off
- MultaRadar: Off
- K Notch: Off
- Radar Options: K Filter (Off or on, depending on test)

Data Collection Procedure:

Using our designed in-house automated test software, we start the test at 2 dB below first detection (known from previous sensitivity tests). The software turns on the source and waits for the audible alert to be picked up by the microphone. The source is then turned off.

This test is run 5 times at each power level. This test is repeated every 5dB starting at/near first detect all the way up to full/strong power levels.

Upon successful testing completion, a minimum, maximum, and average time is established for each of the 5 tests per power level.

Results:

Avg. Response Time	Escort	Competitor 1	Variance	Competitor 2	Variance
K (24.15 GHz) K Filter Off	0.31	0.31	-1%	0.35	-9.8%
Ka low (33.8 GHz)	0.26	0.30	-12%	0.37	-28.8%
Ka mid (34.7 GHz)	0.28	0.32	-12%	0.35	-20.1%
Ka high (35.5 GHz)	0.29	0.57	-50%	0.39	-26.2%

(Data in seconds)

The data provided is for the latest firmware release, with multiple units tested to validate reproducibility. As mentioned above in the settings section, this was conducted with Ka Superwide (no band segmentation).

Field Test:

In the real world, radar guns are subject to variability like drift (where the frequency changes as a function of time), heat, and other environmental factors, so taking this all into consideration plays a critical role in terms of how testing is done.

Distance from the detector, gun polarization, consistency and speed of trigger pull, and measurement tools all matter (see additional notes on testing methodology and standardization).

Equipment Used:

- Falcon HR (K band)
- Genesis VP (K band)
- MPH Bee III (33.8 GHz and POP)
- Stalker II (34.7 GHz)
- Talon (35.5 GHz)

Radar Settings:

- Sensitivity: Highway
- Meter Mode: Spec FR1
- Bands Enabled: X, K, Ka on (Ka Wide)
- TSR: Off
- MultaRadar: Off
- K Notch: Off
- Radar options: K Filter
(Off and on for different tests)

Data Collection Procedure:

Two people are used for this test, one holding the radar gun and the other monitoring the display, ensuring the signal on the display has both appeared and disappeared after each shot.

With a working distance of 50' between the gun and the detector, we tested a Redline 360c and a competitor detector and conducted the test ten times. For this test, we spaced both detectors about 10' apart. We did this to minimize cross-talk, but also measure both units simultaneously. Given that this test is a manual trigger pull (with the exception of MPH Bee III), we wanted to minimize any manual differences they may happen if running individually. Also, as we were not looking to specifically measure frequency or look for false alerts, we feel that the distance between would have negligible impact for response time testing.

Note: The MPH Bee III is the only radar gun with a quick trigger functionality as part of its POP function.

Results:

Table 2. Count of successful detects in 10 shots

Quick Trigger	Escort	Competitor 1
Falcon HR - K (24.15 GHz)	10	10
Genesis VP - K (24.15 GHz)	10	10
Ka low - POP (33.8 GHz)	10	8
Ka mid (34.7 GHz)	10	8
Ka high (35.5 GHz)	10	10

The Redline 360c with K Filter off successfully detected all quick trigger shots.

Sensitivity & Range

Range is a combination of factors including sensitivity, response time, and environmental conditions. Radar detectors were once tested in arid desert conditions with no obstructions or elevation changes on a clear, uninterrupted path. These tests determined capability only in ideal conditions, which defined the best possible range of the detector in free space.

As sensitivities have improved over the years, this test has become elementally less effective. This is because the range of many of the products currently on the market today can reach the curvature of the earth (3 miles) and beyond.

In-Lab Test:

This is an automated test performed with software and hardware that precisely measures response times over a range of police-specific radar frequencies.

Equipment Used:

HP 83640A Synthesized Sweeper in test box (with calibrated horn to account for path loss)

Radar Settings:

Sensitivity: Highway

Meter Mode: Spec FR1

Bands Enabled: X, K, Ka on (Ka Wide)

TSR: Off

MultaRadar: Off

K Notch: Off

Radar Options: K Filter
(Off and on for different tests)

Data Collection Procedure:

We turn on the RF source at a power level that is below the first detection level. The signal strength of the source is then increased in 1dB steps every 3 seconds until the detector alerts for a minimum of 4 seconds.

The same test is performed for the following bands:

X (10.525 GHz)

K (24.150 GHz)

Ka lower (33.800 GHz)

Ka mid (34.700 GHz)

Ka upper (35.500 GHz)

Results:

Table 3. Comparison of Escort Redline 360c sensitivity to two competitors

Quick Trigger	Direction	Escort to Competitor 1	Escort to Competitor 2
K (24.15 GHz)	Front	-3%	3%
Ka low (33.8 GHz)	Front	-1%	-1%
Ka mid (34.7 GHz)	Front	-1%	1%
Ka high (35.5 GHz)	Front	-1%	0%
K (24.15 GHz)	Rear	2%	7%
Ka low (33.8 GHz)	Rear	1%	3%
Ka mid (34.7 GHz)	Rear	2%	2%
Ka high (35.5 GHz)	Rear	1%	3%

Data is measured in dB of sensitivity. Lab set-ups and conditions can vary, so for this test a comparison of a Redline 360c unit was made against two competitor products.

Field Test – Range:

We use a controlled route chosen specifically to replicate realistic driving conditions. With a test vehicle positioned roadside along a corridor over a mile in length, this location incorporated real environmental variables: vegetation, moderate traffic, structures, and other typical urban and suburban obstructions that could influence detection performance.

Equipment Used:

- Falcon HR (K Band)
- MPH Bee III (33.8 GHz and POP)
- Stalker II (34.7 GHz)
- Talon (35.5 GHz)
- GPS Odometer (Free App on Apple)

Radar Settings:

- Sensitivity: Highway
- Meter Mode: Spec FR1
- Bands Enabled: X, K, Ka on (Ka-Wide)
- TSR: Off
- MultaRadar: Off
- K Notch: Off
- Radar options: K Filter (Off and on for different tests)

Data Collection Methodology

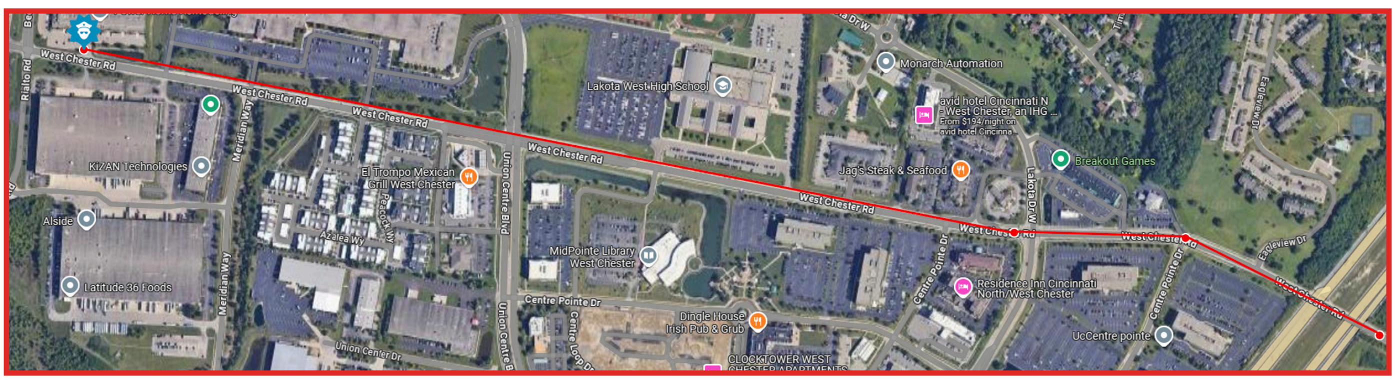
The testing protocol employed a three-person team: an operator positioned on the roadside with radar detection equipment, one designated driver, and one passenger responsible for GPS odometer measurements. Real-time communication via phone was maintained during testing for coordination.

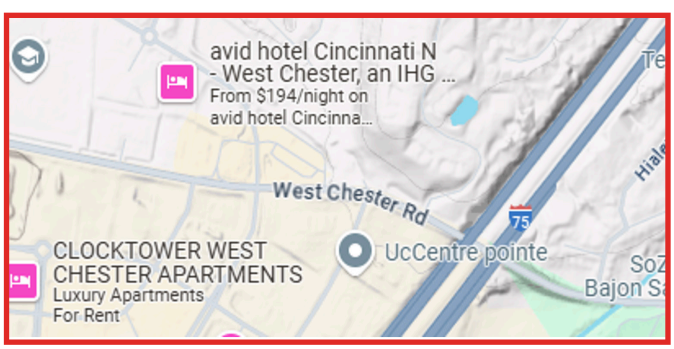
With the passenger communicating trigger timing to the radar operator in advance of each measurement sequence, we would note the initial detection of the radar signal. When a signal is detected, the GPS odometer operator will start recording distance, continuing until the vehicle reaches the actual radar position. Each test sequence consisted of three separate measurement passes.

Test Route Specifications

The designated testing corridor was approximately 1.3 miles in length, originating from the east and climbing to an elevated section that crosses Route 75. This route includes multiple directional changes and several elevation variations.

The straight segment measures approximately one mile in length, with line-of-sight visibility for a quarter mile. The elevation changes along this route directly impacting line-of-sight, with the topography creating nearly a full mile of separation between visual contact and detector capability. Test results demonstrated detection at distances close to one mile away, providing substantial reaction time for most driving scenarios.





Elevation changes along the route.

Results (in Miles):

K Band	Falcon HR	
	Avg.	Std Dev.
Redline 360c	0.989	0.023
Competitor 1	0.947	0.001
Competitor 2	0.957	0.006

Ka Band	Talon (35.5)	
	Avg.	Std Dev.
Redline 360c	1.132	0.028
Competitor 1	1.120	0.051
Competitor 2	1.182	0.065

Ka Band	Stalker II (34.7)	
	Avg.	Std Dev.
Redline 360c	1.133	0.011
Competitor 1	1.089	0.107
Competitor 2	1.141	0.013

Ka Band	MPH Bee III (33.8)	
	Avg.	Std Dev.
Redline 360c	1.196	0.046
Competitor 1	1.203	0.045
Competitor 2	1.202	0.034

Directional Signal Analysis

As the vehicle was passing the signal source, transition timing for directional indicators (front-to-rear arrow progression) was also recorded. These test sequences demonstrated nearly instantaneous directional transitions. It should be noted that environmental factors like proximity to structures and traffic can influence signal directional accuracy and indicator responsiveness.

False Alerts

Our current method for measuring and comparing false alerts is a completely manual process, as we have found real world testing offers real environmental advantages that the lab does not offer.

With a focus on suburban driving, the first test measures sensitivity to constant wave form signals (automated door openers) versus collision avoidance systems (CAS, most commonly found in Blindspot Monitoring Systems). The second component is purely a measure of CAS, used to compare our product to both previous versions of firmware and our competition. When doing this comparison, we try to make sure our settings are set as comparably as possible (e.g. using highway mode for sensitivity, K notch, segmentation or wide band, etc.)

Field Testing:

Conducted over a course of five days, we use a “fresh” radar detector with all stored locations deleted. The test is attempted at the same time every day for consistency of traffic volumes and performed with an identical route and speed. Testing includes a driver and a passenger dedicated to recording data.

Recording the frequency of the signal detected, location, and extra notes using SPEC FR1, we determine signal, direction, and signal strength. We begin the test by clearing the memory of stored locations. Over the five-day period, fixed sources like door openers will get learned and stored (depending on the competition). These are still reported, but they are greyed-out, recorded, and silenced—though some sources can drift depending on temperature AutoLearn™ will determine most locations within three passes, and we expect by the fourth day the number of alerts (audibly) will go down.

Since this test is relative, we compare the number of alerts on average over 5 days to our competition, giving us a sense of how much quieter or noisier we are. Consistency is key: when testing radar Detector A and B, it’s important they are tested at the same time of day in identical conditions. Where possible (e.g. K notch filters, band settings, etc.) the competition is set-up identically.

Equipment Used:

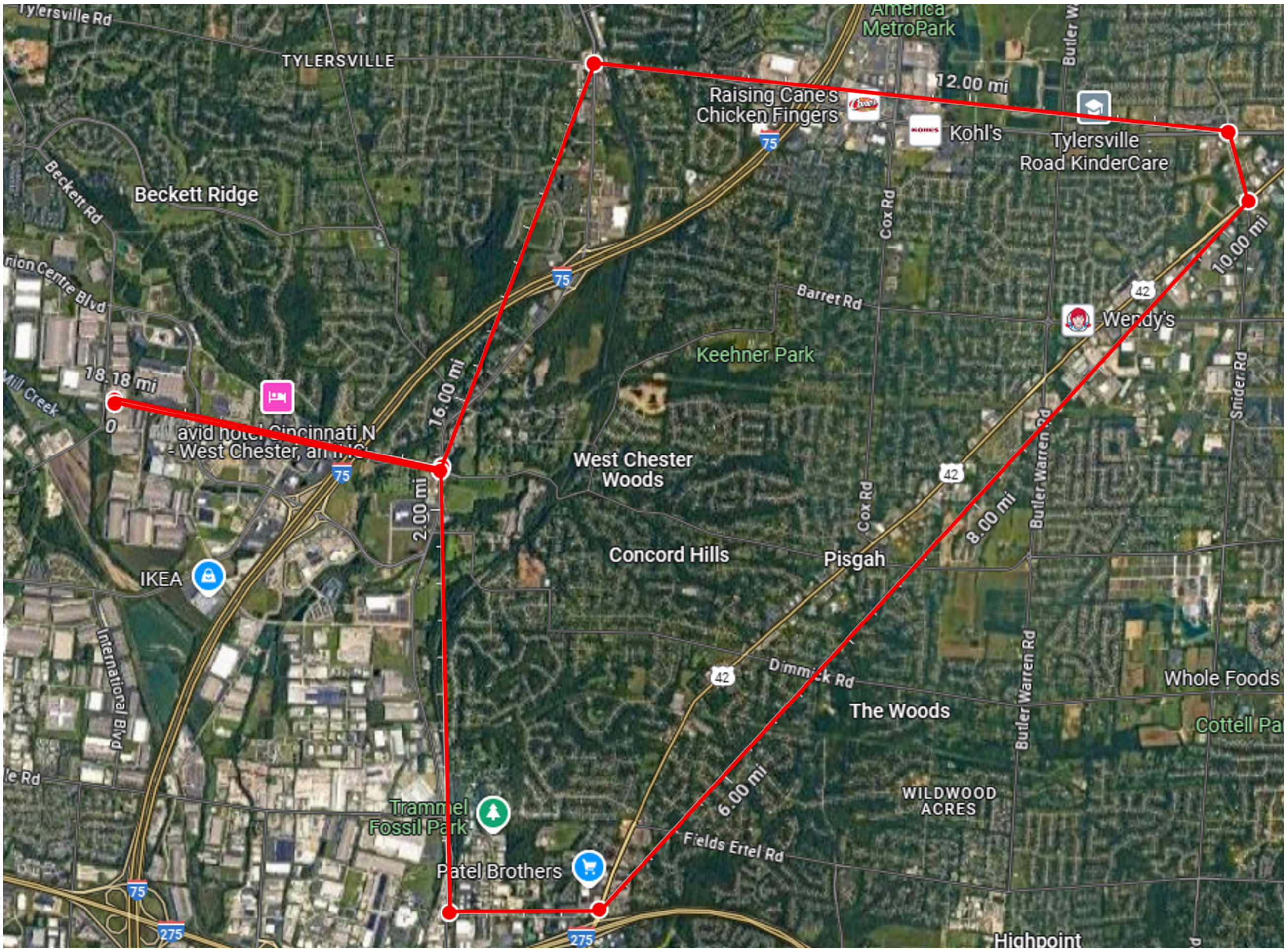
- Redline 360c radar detector (with test firmware)
- Competitor 1
- Competitor 2

Radar Settings:

- Sensitivity: Highway
- Meter Mode: Spec FR1
- Bands Enabled: K, Ka on (Ka Wide)
- TSR: Off
- MultaRadar: Off
- K Notch: On
- Radar Options: K Filter - Off

Data Collection Procedure:

Two individuals – one driving, one recording the data.



Results:

Unique false alerts encountered

Drive Test - False Alerts	Escort (K Filter Off)	Competitor 1	Variance	Competitor 2	Variance
Drive 1	20	30	-33%	19	5%
Drive 2	19	26	-27%	16	19%
Drive 3	12	25	-51%	18	-33%
Drive 4	8	19	-58%	18	-56%
Drive 5	8	20	-60%	17	-53%

Data – count of unique false alerts

The trends show that over the course of five days the number of alerts is reduced by AutoLearn™ learning fixed locations so that only CAS alerts are being reported. A similar trend is observed with one competitor while the other has a flat trend with the alerts reported.

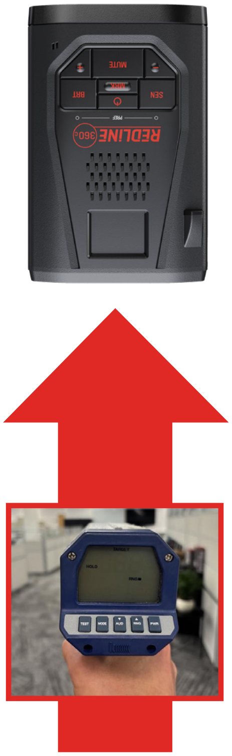
Notes & Interpretation of Results

Polarization, Distance, and Positioning

When used in the manufacturer's recommended configuration, Ka band radar guns emit a vertically polarized waveform, and K band radar guns emit a circular polarized waveform. Like polarized sunglasses that cut glare and reflections, changing the orientation of the radar gun can affect its operation.

To reduce polarization discrepancies, we recommend using the gun as the manufacturer intended, i.e., in the normal (upright) position.

It's also important to note that radar guns should be pointed *directly* at the car and as close to the line of travel as possible to get accurate speed readings.



Any offset/angle between the gun and the car being measured introduces a cosine error. If the police officer is on the side of the road and taking a reading of the car's speed at a 30 degree angle, the measurement at 65 mph will be 65*cos(30 degrees) = 56 mph, or an error of approximately 13% (a 9-mph discrepancy at 65 mph), which is a significant error.

At an angle of 90 degrees, theoretically no speed is measured. This is why the police need to measure speed as close to the edge of the road as possible. Driving on the road with a radar system mounted on the light bar pointing directly at the car is the most accurate way to measure speed.

Radar Detector-Detector Testing

As part of our testing for our Redline 360c model, we also conduct testing for Radar Detector-Detector (RDD) performance using a Spectre RDD. This specialized “radar detector detector” (or RDD) is used by law enforcement to identify the presence of radar detectors in vehicles. It works by detecting the faint radio signals emitted by radar detectors, specifically the local oscillator (LO) frequency. This allows officers to detect the presence of a radar detector even before they can visually identify the vehicle.

This simple test is performed in a large parking lot (about 500' length) by driving towards the RDD and checking to see if it alerts to the presence of our detector. As part of the test, we also compare this with other detectors which report having RDD (or stealth) detection.

RDD Test (Distance in Feet)

	Test 1	Test 2	Test 3	Test 4	Test 5
Redline 360c	0	0	0	0	0
Competitor 1	87	93	96	126	188
Competitor 2	0	0	0	0	0

After repeated passes, the Redline 360c demonstrates that it can’t be detected by RDD tech.

Notes On Testing Standardization

Laboratory Testing

- Automated software-controlled testing for consistency
- Calibrated equipment accounting for path loss
- Standardized detector settings across all tests
- Multiple test iterations (minimum 5 per power level) for statistical validity

Field Testing

- Controlled environmental conditions with consistent timing and routes
- Two-person teams (driver and data recorder) for accuracy
- Standardized distance measurements (50 feet for response time tests)
- Five-day testing cycles to account for adaptive learning features

Technical Considerations

Polarization Effects: Guns upright in position manufacturer intended. Ka-band radar guns emit vertical waves while K-band emits circular waves. Proper gun orientation is essential for accurate testing, as polarization effects can significantly affect signal strength and detection capability.

Environmental Variables: Real-world testing accounts for factors including temperature, traffic volume, and geographic features that laboratory conditions cannot replicate.

Escort Radar took a comprehensive approach to testing, combining laboratory precision with real-world validation to provide our consumers with reliable performance data, enabling informed decision-making in radar detector selection and development.

Summary & Conclusions

We pride ourselves on a standardized and comprehensive approach to radar detector performance testing, with in-depth methodologies for evaluating the three critical performance attributes that consumers prioritize: response time, range, and filtering (or false alert management). The testing framework combines both laboratory-controlled conditions and real-world field testing to provide accurate, reproducible performance metrics.