INFINITION

# BR-2401 Doppler Radar System

A Compact, Integrated Solution for Short-Range Ballistic Velocity Measurement

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# 1. Introduction

This document presents the Infinition BR-2401 Doppler Radar System: a modern, compact K-band radar for muzzle-velocity and short-range ballistic velocity measurement, together with TestCenter 7, the latest generation of Infinition's radar signal processing software. With data acquisition and signal processing integrated directly inside the radar, the BR-2401 is a next-generation instrument that is simpler to install and more affordable to acquire than conventional multi-box systems.

The BR-2401 continuous-wave (CW) Doppler radar delivers next-generation performance for muzzle velocity, short-range velocity and rate-of-fire measurements. It is optimized for small-calibre projectiles, from 5.56 mm up to .50 cal, and also measures calibres up to 40 mm. It is the trusted solution for defence, research and testing environments that require accuracy, reliability and rugged field deployment.

> **The BR-2401 and all Infinition radars are renowned for their reliability over long periods of time, maximizing our customers' operational availability and the efficiency of their measurement campaigns. Our fast, personalized customer service keeps users up and running as much as possible.**

# 2. System Overview

A complete BR-2401 measurement chain consists of three main elements: the BR-2401 radar – with data acquisition and signal processing built in – the muzzle trigger (AT-01 acoustic or OT-01 optical) installed near the gun muzzle, and the TestCenter 7 processing software running on a standard desktop PC. Because acquisition is integrated inside the radar, there is no separate junction box and far fewer cables to deploy. Figure 1 shows a typical indoor range deployment.

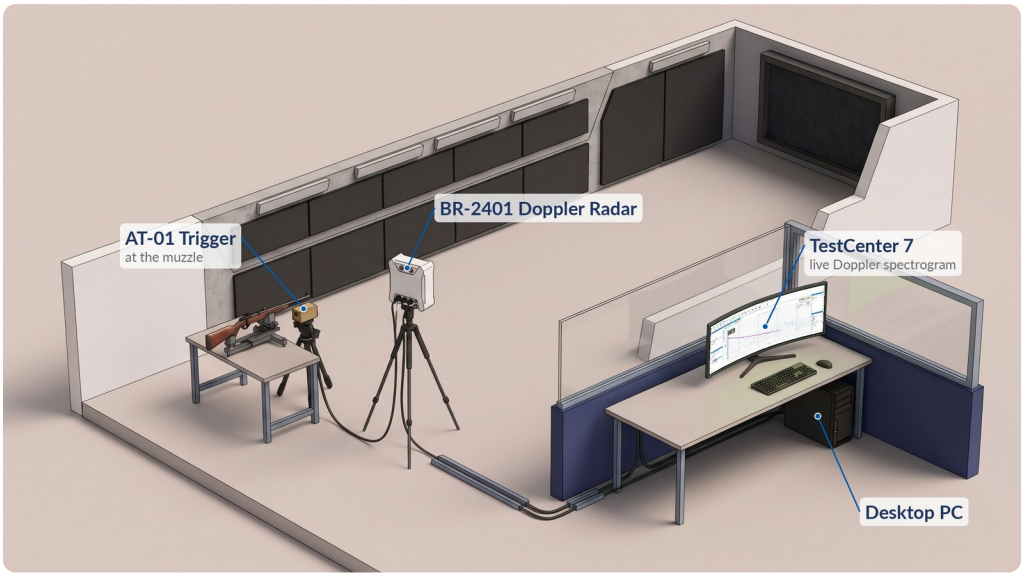


*Figure 1 – Typical set-up of a BR-2401 radar system.*

The measurement sequence is fully automatic:

- **The weapon** is fired and the muzzle trigger instantly provides the precise time-zero reference for the shot.
- **The BR-2401 radar** aligned with the line of fire illuminates the projectile; the Doppler shift of the reflected signal is a direct measure of the projectile velocity along the whole visible trajectory. Data acquisition is integrated in the radar, which digitizes the signal with 16-bit resolution and streams it over Ethernet to the computer, with virtually unlimited recording time.
- **TestCenter 7** processes the signal in real time: muzzle velocity, velocity at any distance, acceleration, rate of fire and complete ballistic results; drag analysis is available with the Advanced version of TestCenter 7.

**Choice of trigger.** The AT-01 acoustic trigger senses the muzzle blast, and the OT-01 optical trigger senses the muzzle flash. Both connect to the same trigger input and only the connecting cable differs, so a single acquisition set-up can use either. One trigger is used at a time, and the operator selects the one best suited to each firing position. The AT-02 trigger is also available for low-noise and subsonic shots, such as suppressed weapons, air rifles, quiet ammunition and subsonic ammunition.



*AT-01 acoustic trigger (left) and OT-01 optical trigger (right).*

## 3. BR-2401 Doppler Radar

The BR-2401 uses a bi-static flat-panel microstrip antenna configuration (separate transmitting and receiving panels) operating in the K-band, in the 24.080 – 24.168 GHz band. The operating frequency is selected from 12 channels spaced 8 MHz apart and is programmed at the factory to the channel requested by the customer, so that several BR-2401 radars can operate simultaneously on the same range without mutual interference. Its ultra-low-noise receiver delivers superior detection range for its class, while on-board signal processing digitizes the Doppler signal directly inside the radar. A 520 nm integrated laser diode provides fast, reliable aiming and alignment on the line of fire.

The housing is a precision-machined, fully sealed aluminum enclosure: lightweight, compact and robust, protected against dust and water and finished in white to minimize solar heating. The BR-2401 operates reliably over a wide range of temperature and weather conditions. A ruggedized 50-ft Ethernet cable is included, connecting the radar directly to the computer and eliminating the need for Doppler coaxial cabling.

## 3.1 Range performance

| Calibre | Range performance (typical / maximum) |
|---|---|
| 5.56 mm (-43 dBsm RCS) | 60 m / 70 m |
| 7.62 mm (-38 dBsm RCS) | 80 m / 100 m |

*Typical range is computed with an FFT size of 1024 and maximum range with an FFT size of 2048, both with a 10 dB minimum signal-to-noise ratio, with the optional 8 mW transmit power (> 27 dBm EIRP). The radar cross section (RCS) shown for each calibre is the value used in the calculation, at the radar frequency of 24.1 GHz – higher than at 10.525 GHz for the same projectile – assuming a flat trajectory with the radar viewing the projectile base. Values marked ">" are deliberately limited: at long range the projectile is no longer seen from its base, its radar cross section falls below the calculated value, and the published range is capped accordingly. These are calculated sensitivity limits, not guaranteed values: actual performance varies with projectile shape and material – particularly base geometry – trajectory profile, radar alignment and test conditions.*

## 3.2 Technical specifications

| | |
|---|---|
| **Antenna gain (Tx / Rx)** | 20 dBi (Tx) / 27 dBi (Rx), min. |
| **Antenna type** | Flat panel microstrip |
| **Beamwidth (Tx / Rx)** | 8° × 18° / 5° × 5° |
| **Polarization** | Vertical |
| **Transmitter output power** | 1 mW standard; 8 mW optional where regulations permit |
| **Transmitter source** | Phase-locked oscillator, CW |
| **Modulation** | None |
| **Frequency** | 24.080 – 24.168 GHz (12 channels) |
| **Velocity measurement accuracy** | ± 0.05 % |
| **System precision** | ± 0.1 % |
| **Data acquisition** | Integrated – 16-bit, Ethernet output |
| **Receiver noise figure** | < 3 dB |
| **Radial velocity coverage** | 30 – 3 000 m/s |
| **Operating temperature** | -20 °C to +55 °C |
| **Storage temperature** | -30 °C to +55 °C |
| **Humidity** | 0 % to 100 % relative humidity (condensing), operating and storage |
| **Power supply** | 12 VDC, 2.0 A max. |
| **Dimensions** | 22.2 cm × 24.6 cm × 7.5 cm |
| **Weight** | 3.4 kg |
| **Approvals** | CE, FCC, ISED |
| **Trigger interface** | AT-01 or OT-01 trigger input; TTL signal via BNC adapter (sold separately); BNC trigger output for multi-instrument synchronization |
| **Aiming laser** | Integrated 520 nm green laser diode, Class 2 (safe for accidental exposure) |

Each radar is programmed to order on one of the 12 channels spaced 8 MHz apart (± 10 ppm), and its frequency is verified before delivery.

**A key design choice:** the BR-2401 integrates data acquisition and signal processing directly inside the radar. This integrated architecture removes the separate junction box, reduces cabling to a single Ethernet link, simplifies installation and lowers the overall acquisition cost – while a precision-machined, fully sealed aluminum housing keeps the unit rugged and field-ready. The result is a modern, efficient and robust instrument that is faster to set up and easier to own.

# 4. TestCenter 7 – Radar Signal Processing Software

TestCenter 7 (released in 2024) is the latest generation of Infinition's Doppler processing software and the productivity benchmark of the industry. It runs on Windows 10 and 11, supports every Infinition radar, is compatible with the JB-6e junction box, and opens TestCenter 6.3.x files.



*Figure 2 – TestCenter 7 on a wide-screen display: Doppler spectrogram with automatic tracking, velocity versus distance, drag coefficient (Cd) versus Mach through the transonic zone, and G7 ballistic coefficient, all from the same shot.*

## 4.1 What sets TestCenter 7 apart

- **New user interface** – a modern ribbon interface with dockable windows and simplified dialogs; the complete workflow (acquisition, spectrogram, velocity, drag) fits on a single ultrawide display, as shown in Figure 2.
- **Dynamic graphic engine** using 3D acceleration, with layer management and dynamic display: results are viewed and manipulated fluidly even on very large data sets. You can act directly on the graphs – a single click adds or optimizes measurement cursors right on screen.
- **Automatic analysis** – V0 and Vx measurements, track detection and burst tracking are fully automatic; a complete shot analysis takes seconds.
- **Project and series management** – a complete Project Manager including series and shot management: information is filed as the trials are performed, so you always know exactly where you stand in the current project during a firing campaign. Compare tracks across a series and get live statistics (average, extreme spread, standard deviation) as shots accumulate.
- **Batch processing** – modify analysis parameters and apply them to an entire series in a single operation, to uniformize results quickly and efficiently, with instant statistics update.
- **Reporting** – export every result table and curve to CSV, and copy any graph in one click for fast sharing of information. CSV is an open format, read by any analysis, reporting or database software, so results can be merged with data from other range instrumentation – no proprietary format and no dedicated import tool.

## 4.2 Ballistic analysis capabilities

On every shot, TestCenter 7 provides:

- **Velocity, distance and acceleration** – velocity vs time, velocity vs distance (derived using Integrated Velocity Ranging), distance vs time, acceleration vs time and acceleration vs distance; every curve and its underlying values are exportable to CSV.
- **Spectrogram** – the full Doppler signal is displayed as a velocity/time spectrogram. The automatic tracker locks on the projectile and measurement cursors (V0, V500, V1000 or any custom distance) are placed automatically, with velocity, distance and time reported for each.
- **Drag analysis (Cd vs Mach)** – available with the Advanced version of TestCenter 7, which includes the drag analysis module: measured drag coefficient as a function of Mach number, computed through the transonic zone, with trajectory prediction based on PM or MPM ballistic models. This measured-drag capability is a decisive advantage for ammunition characterization and acceptance testing.
- **Burst and rate of fire** – automatic tracking of every round of a burst, with the rate of fire and per-round statistics, and velocity tracking on multiple simultaneous projectiles.
- **In-bore measurement** – velocity and acceleration of the projectile along its travel inside the barrel, up to muzzle exit.

# 5. Scope of Supply and Support

## 5.1 Standard configuration – 1 complete set

The BR-2401 system is supplied as a complete, ready-to-operate set. A typical complete set includes:

- **BR-2401 Doppler radar** – 12 VDC powered, with integrated data acquisition and signal processing and a 520 nm aiming laser.
- **Ruggedized 50-ft Ethernet cable** – direct connection to the computer; no separate junction box or Doppler coaxial cabling required.
- **TestCenter 7 software license** – radar signal processing and ballistic analysis.
- **AT-01 acoustic trigger** – installed near the gun muzzle, with trigger cable. The BR-2401 accepts a TTL signal through a BNC adapter on its trigger input (sold separately) and provides a BNC trigger output for synchronizing additional instruments; the BNC synchronization cable is supplied on request.
- **Tripod and accessories** – everything required for deployment.
- **User documentation** – operation and analysis manuals.

**Available options:** TestCenter 7 Advanced (drag analysis module), OT-01 optical trigger, AT-02 trigger for low-noise and subsonic shots, in-bore measurement module. For longer trajectories and extended range, Infinition also offers dedicated long-range Doppler radars.

## 5.2 Acquisition computer

TestCenter 7 runs on a standard desktop PC with the following minimum configuration: Windows 10 and 11, Intel Core i5 processor or better, 16 GB RAM, SSD drive and Ethernet port. An ultrawide display is recommended to take full advantage of the TestCenter 7 workspace shown in Figure 2.

## 5.3 Calibration and service

Calibration is supported directly by the manufacturer. The recommended approach is to return the equipment to Infinition's laboratory in Canada for a complete verification; the system is shipped back fully functional with its calibration certificate. Combined with our fast, personalized customer support, this keeps your system measuring – and your teams up and running.

# 6. Why Infinition

Infinition is a Canadian company in operation for more than 30 years, with a reputation proven around the world by the most reputable clients in the industry.

- **A complete radar range** – from in-bore measurement at 122.5 GHz and Ka-band laboratory radars to X-band radars for small arms, medium calibres and artillery, Infinition covers every calibre and every range with one family of instruments.
- **Proven reliability** – Infinition radars are extensively field-tested and recognized for a reliability that keeps our customers measuring, campaign after campaign.
- **Productivity** – TestCenter 7 automates the complete analysis workflow; results that used to require manual processing are produced in seconds, by any trained operator.
- **Investment protection** – all Infinition radars share TestCenter 7, TestCenter 6.3.x files can be opened, and a system grows with your needs: a second radar on the same JB-6e, a TH-1000 tracking head or optional analysis modules.
- **Single-source support** – Infinition designs and manufactures the radar, the acquisition hardware and the software in-house, and provides installation, on-site training and calibration services worldwide.

# 7. Contact

**Request a quotation, a demonstration or technical information**

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