APPLICATION NOTE · VETERINARY DIAGNOSTICS · HEMATOLOGY

Photodiode Detection in Veterinary CBC and Blood Cell Analysis

Inside every veterinary blood analyzer, an optical detector does the counting. This note matches Opto Diode's silicon photodiodes, low-dark-current detectors, and silicon avalanche photodiodes to the four jobs of a CBC: sizing cells by light scatter, flagging subsets by fluorescence, and reading hemoglobin by absorbance. It covers flow-cytometry analyzers, 5-part WBC differentials, and reticulocyte and platelet channels.

FEATURED COMPONENT

Low-Dark-Current Silicon Photodiode

Large-area silicon detector for forward- and side-scatter collection and 540 nm hemoglobin photometry. Broad visible response, low dark current, hermetically sealed package.

WAVELENGTH	350 nm – 1100 nm
ACTIVE AREA	up to 100 mm^2
RESPONSIVITY	0.45 A/W @ 650 nm
DARK CURRENT	down to 0.1 nA

WHAT YOU'LL LEARN

- L.01 Light scatter (FSC / SSC) matched to cell size & complexity
- L.02 Low dark current for weak side-scatter and fluorescence
- L.03 Silicon APDs for reticulocyte & low-event fluorescence
- L.04 Blue-enhanced silicon for 540 nm hemoglobin photometry

WHO IT'S FOR

- A.01 Veterinary hematology analyzer designers
- A.02 Flow-cytometry CBC reader teams
- A.03 WBC 5-part differential developers
- A.04 Reticulocyte & platelet channel engineers

Overview

A veterinary CBC counts and classifies millions of cells from a few microliters of whole blood, then reports hemoglobin, indices, and a differential a clinician can act on, in minutes, on a clinic bench. Optics do the work: scatter sizes and sorts the cells, fluorescence flags reticulocytes and white-cell subsets, and absorbance reads hemoglobin. Every one of those measurements rests on a photodiode chosen for its channel.

01 · APPLICATION CHALLENGE

01 Count millions of cells, classify each, and read hemoglobin from microliters.

A complete blood count is, at heart, a sorting problem run at speed. Hydrodynamic focusing lines the cells up single-file through a laser, where each one scatters light: forward scatter tracks cell size, side scatter tracks internal complexity and granularity. From those two signals alone, an analyzer separates red cells, platelets, and the five white-cell populations, thousands of events a second, every second.

Veterinary samples make that harder than a human bench ever does. A single analyzer has to run feline, canine, equine, and exotic blood, and red-cell size, platelet size, and the degree of overlap between populations shift from one species to the next. The optical detection has to hold its resolution across all of them, with no chance to re-tune between patients.

Two of those signals are faint. Side scatter and the fluorescence from nucleic-acid dyes, which flag reticulocytes and resolve the white-cell differential, sit far below the forward-scatter peak. A detector that leaks dark current, drifts with temperature, or saturates on the bright channel erases the very distinctions the count depends on.

And it has to do all of this on a clinic bench, not in a reference lab. It runs through temperature swings, vibration, and years of daily use, between calibrations that are weeks apart. The optical front end is the one part of the instrument that cannot drift: every count, index, and differential the analyzer reports traces straight back to what these detectors measure.

02 · DESIGN PRINCIPLE

02 Match the detector to the channel, not the instrument.

Every optical channel asks for a different detector. Forward scatter is bright and wants a large-area silicon photodiode with clean linearity. Side scatter and fluorescence are dim and want low dark current, and when the signal is truly scarce, the internal gain of a silicon avalanche photodiode. Hemoglobin is an absorbance reading near 540 nm, where a blue-enhanced silicon detector responds cleanly.

Specify each detector where its channel actually lives. Active area and linearity for scatter, dark current and NEP for fluorescence, spectral response at 540 nm for photometry. One general-purpose diode stretched across every channel compromises all of them at once.

DESIGN PRINCIPLE · 02

One analyzer, several detectors, each matched to its channel.

Forward scatter, side scatter, fluorescence, and hemoglobin photometry are four measurements sharing one optical bench. Treat them as four detector problems: large-area linear silicon for FSC, low-dark-current silicon or an APD for SSC and fluorescence, and blue-enhanced silicon at 540 nm for HGB. Matching each channel beats over-specifying one diode for all.

TBL.00 — GENERIC VS. FIELD-ENGINEERED DETECTORS

PARAMETER	GENERIC DETECTOR	OPTO DIODE FAMILY	WHY IT MATTERS
Scatter Linearity	One-size-fits-all diode	Large-area, matched silicon	Holds size resolution from platelets to RBCs
Weak-Signal Gain	PIN silicon only	Silicon APD (internal gain)	Lifts side-scatter & fluorescence above noise
Photometry Match	Flat general-purpose response	Blue-enhanced silicon @ 540 nm	Accurate hemoglobin absorbance reading
Long-Term Stability	Commercial-grade part	Low-dark-current, hermetic, screened	Same count and HGB on day one and year five

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03 · ENGINEERING SELECTION

A practical framework for the CBC optical bench.

Start at the laser. Most veterinary hematology benches read with a red diode laser near 635–650 nm, so forward- and side-scatter detectors should respond cleanly across the visible to near-IR where that scatter lands — silicon covers it. Size the active area to the collection optics: large for the forward-scatter path, tighter for the 90° side-scatter pickup.

Then set gain by the photon budget. Bright forward scatter reads on a low-dark-current silicon PIN photodiode, where linearity and channel matching dominate. Dim side scatter and reticulocyte or differential fluorescence benefit from a silicon APD's internal gain. Run the hemoglobin channel on a blue-enhanced silicon detector matched to the 540 nm absorbance line, and keep it stable for calibration over the instrument's life.

WAVELENGTH	CHANNELS	PHOTOMETRY	GAIN	NOISE	PACKAGE
350 – 1100 nm	FSC / SSC / Fluor	540 nm HGB	PIN or APD	Low dark current	Hermetic, matched

TBL.01 — OPTO DIODE FAMILIES FOR VETERINARY HEMATOLOGY

TECHNOLOGY	FAMILY	SPECTRAL RANGE	FORM	TYPICAL USE
Large-Area Silicon	Silicon photodiode	350 – 1100 nm	Single, large area	Forward-scatter (cell size) collection
Low-Dark-Current Si	Silicon PIN photodiode	350 – 1100 nm	Single / multi	Side-scatter & general optical channels
Silicon APD	Silicon avalanche	400 – 1100 nm	Single (500 µm)	Reticulocyte & differential fluorescence
Blue Enhanced Si	Silicon photodiode	350 – 1100 nm	Single element	540 nm hemoglobin photometry
Matched Detector Set	Silicon, screened	350 – 1100 nm	Multi-element	Multi-angle scatter, channel matching
Red / IR LED Emitter	AlGaAs emitter	Red / 850 – 940 nm	Emitter	Source monitoring & illumination

TBL.02 — COMMON FAILURE MODES IN OPTICAL HEMATOLOGY

MODE	ROOT CAUSE	DESIGN RESPONSE
Bright-channel saturation	Forward scatter overdrives the detector	Large-area linear silicon, wide dynamic range
Weak-signal miss	Side scatter / fluorescence below the noise floor	Low-dark-current silicon or APD internal gain
Hemoglobin drift	Photometry detector drifts with temperature	Stable blue-enhanced silicon, hermetic seal
Channel mismatch	Unmatched discrete scatter detectors	Matched, screened detector sets

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04 · PRODUCT FIT

Recommended Opto Diode building blocks.

TBL.03 — DETECTOR & SOURCE FAMILIES BY CBC CHANNEL

PART / FAMILY	CHANNEL / APPLICATION	FORM / PACKAGE	WHY THIS PART
Large-Area Silicon	Forward scatter — cell size	Single, large active area	Linear across the full size range
Low-Dark-Current Si	Side scatter — complexity	Single / multi, hermetic	Resolves dim 90° scatter cleanly
Silicon APD	Reticulocyte & WBC fluorescence	Single, 500 µm, hermetic	Internal gain raises weak labels above noise
Blue Enhanced Si	Hemoglobin photometry @ 540 nm	Single element, low dark current	Responsivity matched to the HGB line
Matched Detector Set	Multi-angle scatter arrays	Multi-element, screened	Channel-to-channel consistency
Red / IR LED Emitter	Source monitoring / illumination	AlGaAs emitter	Stable reference matched to detectors

KEY FEATURES

- Large-area silicon for linear forward scatter
- Low dark current for dim side-scatter & fluorescence
- Silicon APD internal gain for reticulocyte channels
- Blue-enhanced response for 540 nm photometry
- Matched, screened multi-element detector sets

APPLICATIONS

- Flow-cytometry CBC analyzers
- 5-part WBC differential systems
- Reticulocyte & nucleated-RBC channels
- Platelet counting & optical platelet channels
- Hemoglobin photometry & optical density

BUILT FOR PRECISION

- Hermetic TO and ceramic packages
- Glass-to-metal seals, no epoxy near die
- Low dark current, tight channel matching
- Matched detector and emitter sets
- ISO 9001:2015 certified

CUSTOM PROGRAMS

Engineered to your bench.

Opto Diode builds detectors around your optical bench: active areas sized to the forward- and side-scatter optics, blue-enhanced response tuned to the 540 nm hemoglobin line, low-dark-current and APD options for the fluorescence channels, and matched, screened sets for multi-angle scatter. Everything is assembled in-house under ISO 9001:2015, with the screening and documentation a diagnostic program demands. Qualification samples typically ship in 8 to 12 weeks.

NEXT STEPS

Talk to Applications Engineering.

Send us your laser wavelength and scatter geometry, the channels you run, your hemoglobin method, and the throughput and qualification standard you have to meet. We'll come back with a recommended standard family, or a custom path, within one engineering review cycle.

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