TRADEWAYS LTD

APTEC-NRC

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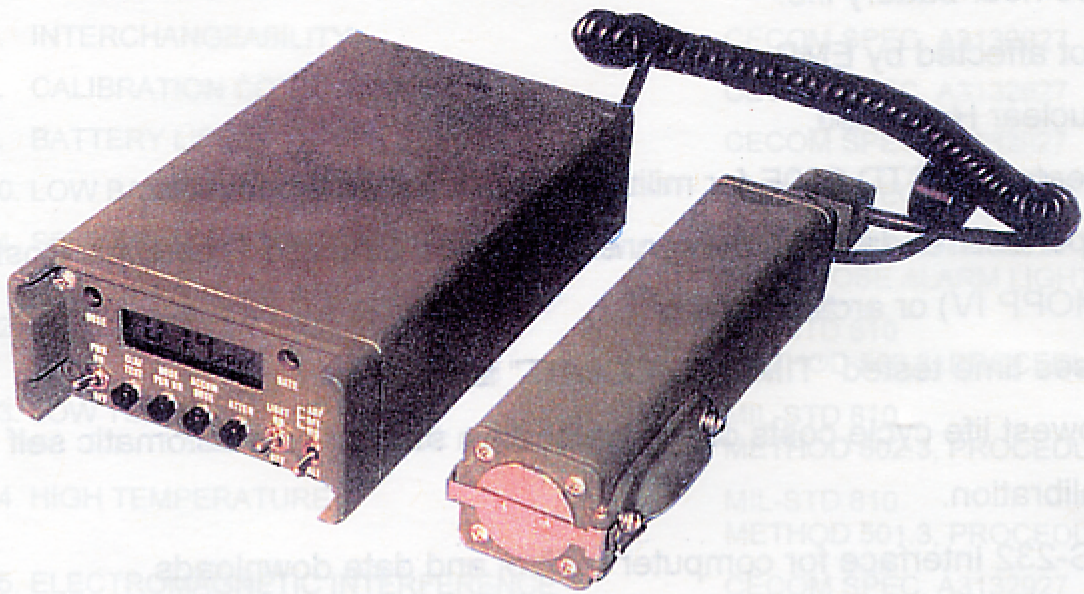
MILITARY PRODUCTS

AN/VDR-2

MILITARY RADIAC
AN/VDR-2

DESIGNED WITH THE SOLDIER IN MIND...

* TACTICAL
* PORTABLE



AN/VDR-2 MILITARY RADIAC

CAPABILITIES - FEATURES

- The direct reading AN/VDR-2 detects and quantifies dose rate from 0.001 µGy/hr to 999 cGy/hr. It also measures gamma dose from 0.001 µGy to 999 cGy.
- Presettable audio and visual alarms.
- Overall accuracy better that ± 15% over entire dynamic range in severe military environments.
- 150 hour battery life.
- Not affected by EMP.
- Nuclear Hardened.
- Meets MIL-STD-810E for military operational environments.
- Operable/readable by personnel in Mission Oriented Protection Posture (MOPP IV) or arctic clothing.
- Uses time tested "TIME-TO-COUNT" technology.
- Lowest life cycle costs due to calibration stability and automatic self calibration.
- RS-232 Interface for computer control and data downloads.
- Qualification tested and typed classified by US Army.

Qualification Testing Conducted On AN/VDR-2

The AN/VDR-2 Radiac Set was developed by Aptec-NRC under contract to the US Army. The Radiac Set was designed and constructed to meet the requirements of the US Army Performance Specification A3132927 dated 08 Aug 1991 and MIL-STD-810C (Environmental requirements). Upon completion of development and fabrication, the AN/VDR-2 was evaluated by White Sands Missile Range, (US Army) and type classified as standard for US Army service. The following list includes the salient testing (and related test documents) conducted during the Radiac Set evaluation.

Test Performed	Specification
1. RADIATION DOSE/DOSE RATE ACCURACY	CECOM SPEC. A3132927
2. GAMMA DOSE ACCURACY	CECOM SPEC. A3132927
3. PRECISION	CECOM SPEC. A3132927
4. RESPONSE	CECOM SPEC. A3132927
5. SECURE LIGHTING	CECOM SPEC. A3132927
6. WEIGHT AND SIZE	CECOM SPEC. A3132927
7. INTERCHANGEABILITY	CECOM SPEC. A3132927
8. CALIBRATION COMPATIBILITY	CECOM SPEC. A3132927
9. BATTERY LIFE	CECOM SPEC. A3132927
10. LOW BATTERY INDICATION	CECOM SPEC. A3132927
11. SECURE LIGHTING	CECOM SPEC. A3132927 RATE/DOSE ALARM LIGHTS
12. ALTITUDE	MIL-STD 810 METHOD 500.3, PROCEDURE II
13. LOW TEMPERATURE	MIL-STD 810 METHOD 502.3, PROCEDURE I/II
14. HIGH TEMPERATURE	MIL-STD 810 METHOD 501.3, PROCEDURE II
15. ELECTROMAGNETIC INTERFERENCE	CECOM SPEC. A3132927
16. SAND AND DUST	MIL-STD 810 METHOD 510.3, PROCEDURE I
17. EXPLOSIVE ATMOSPHERE	MIL-STD 810 METHOD 511.3, PROCEDURE I
18. RAIN	MIL-STD 810 METHOD 506.3, PROCEDURE II
19. SALT FOG	MIL-STD 810 METHOD 509.3, PROCEDURE I

Test Performed	Specification
20. IMMERSION	MIL-STD 810 METHOD 512.3, PROCEDURE 1
21. VIBRATION AND SHOCK	MIL-STD 810 METHOD 514.3, CATEGORY I
22. VIBRATION, LOOSE CARGO	MIL-STD 810 METHOD 514.3, PROCEDURE II
23. TRANSIT DROP TEST	MIL-STD 810 METHOD 516.3, PROCEDURE II/IV
24. SYSTEM SAFETY DESIGN CHECKLIST	CECOM SPEC. A3132927
25. HUMIDITY	MIL-STD 810 METHOD 507.3, PROCEDURE III
26. FUNGUS	MIL-STD 810 METHOD 507.3, PROCEDURE III
27. CALIBRATION COMPATIBILITY	CECOM SPEC. A3132927
28. BATTERY LIFE	CECOM SPEC. A3132927
29. RESPONSE	CECOM SPEC. A3132927
30. GAMMA ENERGY DEPENDENCE	CECOM SPEC. A3132927
31. ALARMS	CECOM SPEC. A3132927
32. DECONTAMINATION	CECOM SPEC. A3132927
33. ELECTROMAGNETIC-PULSE	USANCA CRITERIA FOR NUCLEAR HARDNESS
34. THERMAL RADIATION	USANCA CRITERIA FOR NUCLEAR HARDNESS
35. AIR BLAST	USANCA CRITERIA FOR NUCLEAR HARDNESS
36. RELIABILITY TEST	USANCA CRITERIA FOR NUCLEAR HARDNESS
37. BURN-IN RADIAC SET AN/VDR-2	CECOM SPEC. A3132927
38. WORKMANSHIP	CECOM SPEC. A3132927
39. FINISH	CECOM SPEC. A3132927
40. MARKING	CECOM SPEC. A3132927
41. TESTABILITY (BIT)	CECOM SPEC. A3132927

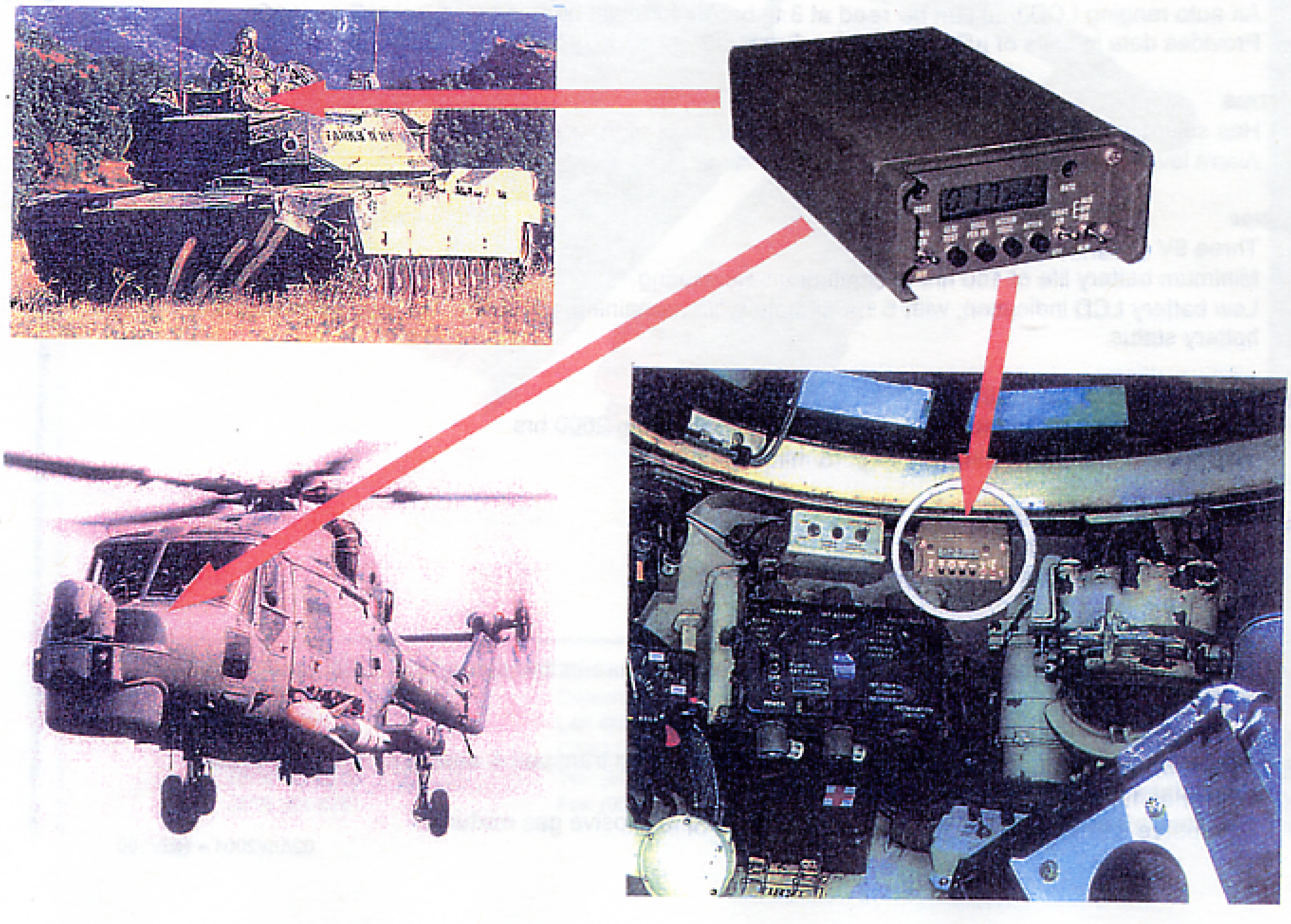
FOR USE WITH:

Troops

The AN/VDR-2 Radiac is suitable for both Tactical and non-Tactical Radiation Protection use. This simple to operate, rugged, and lightweight equipment combines unequaled performance and reliability. Features such as wide dynamic ranges for dose and dose rate, and presettable alarms make this instrument clearly the instrument of choice for the foot soldier.

Land Vehicles and Helicopters

The AN/VDR-2 Radiac is equally compatible with operation and use in all military Land Vehicles and Helicopters. Capable of operating on vehicular or aircraft power, the AN/VDR-2 Radiac easily fits into the tightly crammed interiors of aircraft and fighting vehicles (see circled AN/VDR-2 below). Detection probes may be mounted outside the Land Vehicle or Helicopter and can operate in conjunction with the detector of the internally located AN/VDR-2 to provide complete radiation assessments. Additionally, when used with an onboard computer, the RS-232 port pf the AN/VDR-2 enables real time data to be provided to the computer such that dose rate mapping or iso-dose curves can be provided.



AN/VDR-2
SPECIFICATIONS

Data Provided
- **Gamma Radiation:** 0.001µGy/hr to 999 cGy/hr (dose rate) & 0.001µGy to 999 cGy (total dose).

Features
- **Pre-settable Audible and Visual:** dose and dose rate alarms.
- **Setup Time:** for all checks and alarms less than 1 minute.
- **Accuracy:** ± 15%.
- **Circuit Protection:** AN/VDR-2 is Nuclear and EMP hardened.
- **EMI compatibility:** Will not be effected, or cause other equipment to be effected, by its use.
- **Operable and Readable:** By persons wearing Arctic and MOPP protective clothing.
- **Weight:** 3.8 pounds (1.73 kg).
- **Volume:** 58 cubic inches (909 cc).
- **Dimensions: 7.5 in (18.2 cm) x 4.125 in (10.4 cm) x 1.875 in (4.8 cm).**

Detectors
- **Two GM Tubes**
- **Reads in Tissue:** Dose centigray (cGy) other readout units available on request (Rads or Sieverts).
- **Gamma Energy Dependence:** ± 20%, 80 keV to 3 MeV.
- **Total (Cumulative) Dose Readout:** Will not be erased when read, resettable to zero as desired.
- **Dose Rate:** Minimum detectable level - 0.001 µGy/hr.
- **Response time:** Within 10% of final reading in 4 seconds at 1.0 cGy/hr, returns to background within 4 seconds.

Display
- An auto ranging LCD that can be read at 3 ft, backlit for night use, updated every 2 seconds.
- Provides data in units of µGy, cGy, Gy, µGy/hr, cGy/hr and Gy/hr.

Alarms
- Has selectable Visual and Audible indicators for day or night use.
- Alarm levels are settable over entire dynamic range.

Power
- Three 9V batteries.
- Minimum battery life of 150 hrs of continuous monitoring.
- Low battery LCD indication, with 5 hrs of battery life remaining, a ""Go/No Go" feature provides battery status.

Reliability and Maintainability
- **The Mean Time Between Failures (MTBF):** greater than 2000 hrs
- **The Mean Time To Repair (MTTR):** 15 min.

Environmental Parameters
- **Operating Temperature:** -51°C to +50°C
- **Storage/Transport Temperature:** -60°C to + 70°C.
- **Humidity:** 0-100%.
- **Immersion:** 3 feet for at least 2 hrs.
- **Sand/Dust:** Operates in winds to 1750 ft/min with exposure to fine dust and to 5700 ft/min to sand particles.
- **Fungus:** Built from inherently fungus resistant materials.
- **Vibration & Shock:** Withstands vibration associated with transport & shocks of dropping in use.
- **Altitude:** 40,000 feet (12,192 meters).
- **Explosive Atmospheres:** Will not cause ignition of explosive gas mixtures.

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TIME-TO-COUNT TECHNIQUE

NRC GM tube detectors are operated using a unique technique, which removes many of the limitations associated with the use of G-M tubes operated in the conventional mode.

Conventionally, a G-M tube is operated with a fixed DC voltage continuously applied. Readings of rate are a function of the number of pulses (counts) produced by the tube per unit time. This type of operation is characterized by increasing non-linearity as the field intensity increases. This effect, due to the inherent "dead time" of the tube, limits its range of usefulness. The problems associated with the conventional DC mode of operation are best understood by examining the "Stever Pattern", produced by the tube in response to a radiation field.

Assume the G-M tube is energized and the first pulse is produced by the tube in response to an ionizing event. This initial pulse will be full-size and will typically be properly counted. Following the initiation of this pulse is a recovery period during which the discharge mechanism is operating within the tube. During the recovery time, if another ionizing event occurs in the tube, it cannot be detected. This time is defined as the dead time. If an ionizing event occurs immediately following the dead time, a small pulse, barely detectable, could be observed.

Dead time varies with the dimensions of the tube, the operating impedance, the mobility of the tube gases, and, to a lesser extent, the operating voltage.

The dead time of the low range tube used in NRC GM tube detectors is about 150 microseconds; the high range tube dead time is about 15 microseconds. If an ionizing event takes place a trifle later than the dead time, the pulse produced would be larger.

Finally, a time will occur when the pulse formed is of full height; i.e., equal to the amplitude and shape of the initial pulse observed. This time is called the recovery time, and corresponds to the time when the positive ion sheath (formed during the discharge mechanism) is neutralized at the outer wall of the G-M tube. The dead time, which characterizes all G-M tubes, produces the non-linearity at higher fields and severely limits the range over which the tube is usable.

A second undesirable characteristic of G-M tube operation in the conventional mode is saturation. It can be seen that as the field intensity is increased, more and more ionizing events will arrive in close proximity to the dead time. The pulses produced by the tube will become smaller and smaller and eventually will no longer trigger the input circuit of the instrument in which it is being used, causing the reading to drop to very low values or zero. Most G-M tube instruments currently produced will display this hazardous condition. In the TIME-TO-COUNT technique employed in NRC GM tube detectors, the dead time and saturation effects are eliminated.

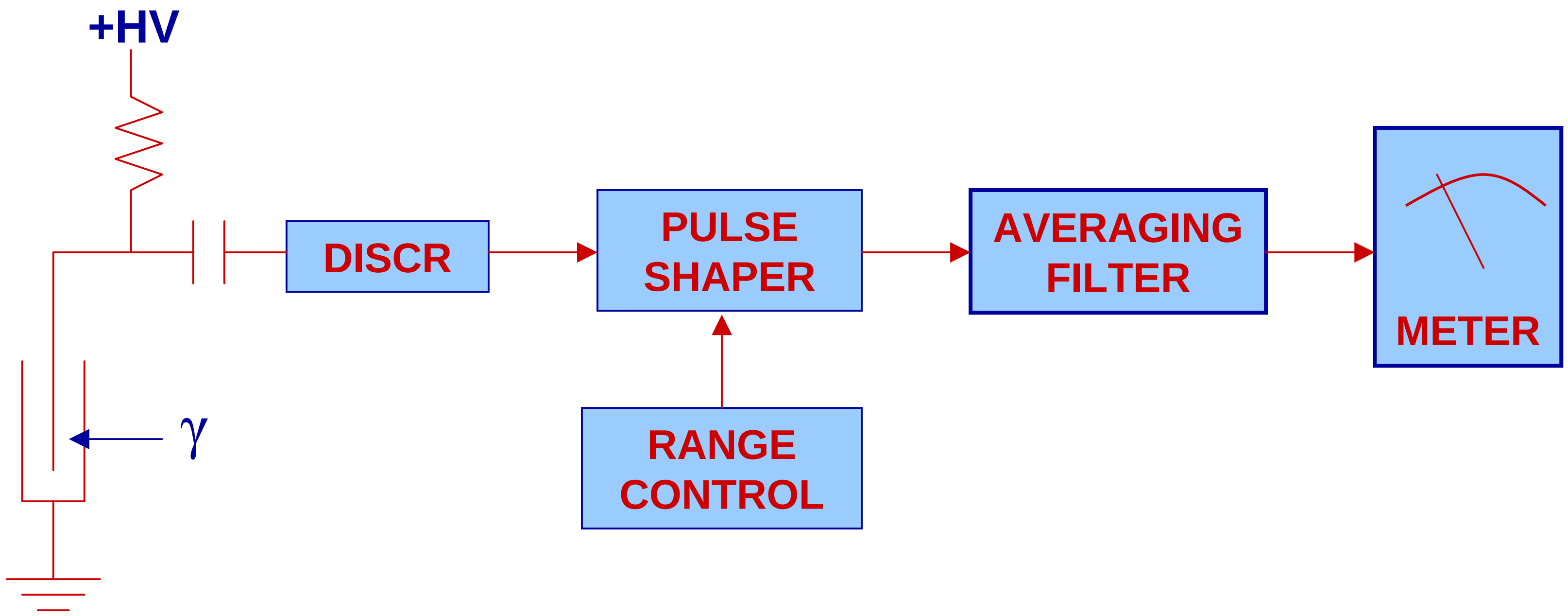
A low DC bias voltage is abruptly raised to 500 volts DC carrying the tube into its operating region. The rise time of this voltage is less than 0.2 microseconds. At the same time, this rapid increase in voltage is applied, a crystal controlled, 1 megacycle oscillator (clock) is gated on and time, in the form of 1 microsecond cycles, starts being counted. Time counting continues until a G-M tube pulse is obtained. At that point, time counting is stopped and the accumulated time is recorded. At the same time, the anode voltage is reduced into the low bias level. The voltage on the anode is maintained at the low bias level for 1.5 to two milliseconds, a time period which is long compared to the dead time and recovery time of the tube.

After two milliseconds, when the G-M tube is fully recovered, the voltage is again applied to the anode. Only one G-M tube pulse can occur in any one 'on' time. Since the tube is fully recovered between on-times, the pulses produced by the tube are full size. The process is repeated many times to obtain a statistically reliable average time-to-count. In this fashion, dead time losses are eliminated and saturation cannot occur.

Thus, the radiation field intensity is proportional to the reciprocal of the time required to obtain a G-M count. Looking at a single event of a random nature would be statistically unreliable. However, if this measurement is repetitively made over a defined period of time (for example: 2 seconds), and the average time to obtain a G-M pulse is determined, we now have a statistically reliable measure of field strength. This precise microprocessor controlled relationship forms the design basis for NRC GM tube detectors and enables many decades of linear performance for the two G-M tubes involved.

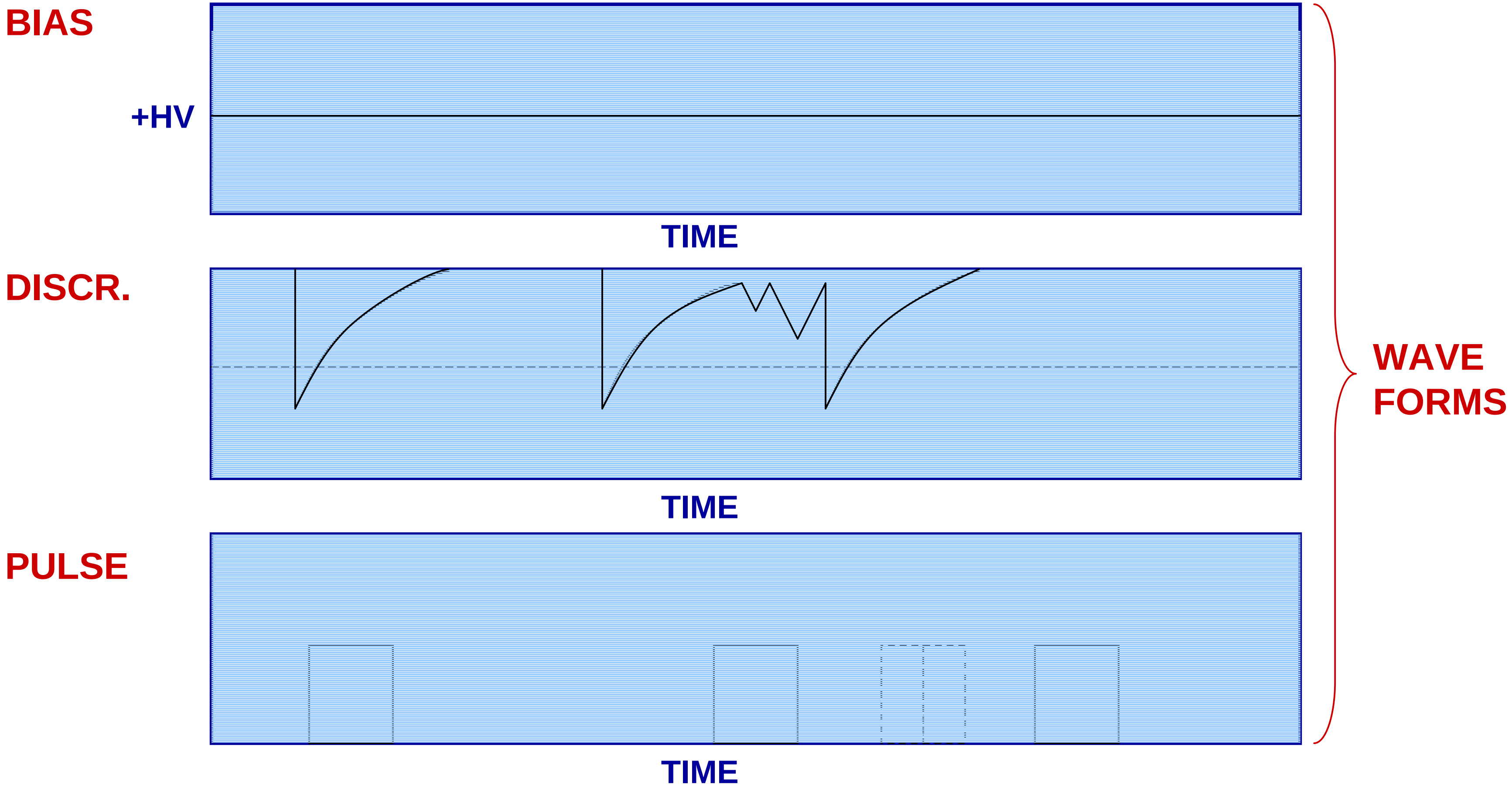
OPERATING PRINCIPLES – OPERATIONAL KIT

Typical GM Tube Instrument



OPERATING PRINCIPLES – OPERATIONAL KIT

Conventional GM Tube Instrument Operation



OPERATING PRINCIPLES – OPERATIONAL KIT

GEIGER-MÜLLER (GM) TUBES

ADVANTAGES

- WORKHORSE
- HIGH GAIN
- SIMPLE ELECTRONICS

DISADVANTAGES

- DEAD TIME NON-LINEARITY
- SATURATION / FOLDOVER
- LIMITED LIFE (10^8 TO 10^{10} COUNTS)

OPERATING PRINCIPLES – OPERATIONAL KIT

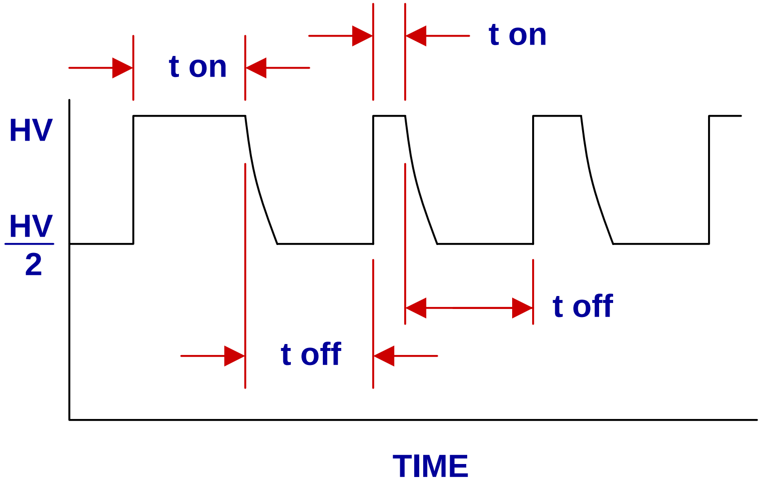
“Time to Count” Operation

Canberra Dover has eliminated the inherent disadvantages of GM Tubes with the development of “Time to Count”.

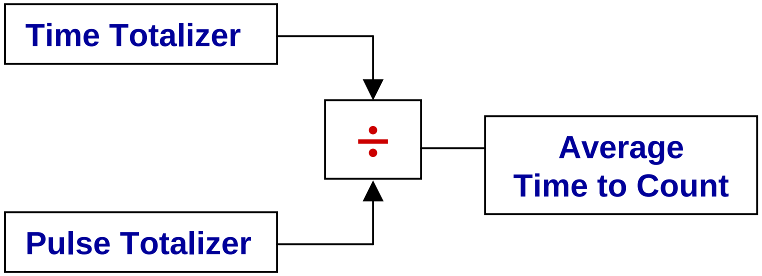
- **GATED HIGH VOLTAGE TO GM TUBE**
- **GUARANTEED FULL RECOVERY**
- **NO DEAD-TIME NON-LINEARITIES → SINGLE POINT CALIBRATION**
- **NO DEAD-TIME INDUCED SATURATION OR PARALYSIS**
- **LONG LIFE (MAXIMUM COUNTRATE 500/SECOND)**

OPERATING PRINCIPLES – OPERATIONAL KIT

"Time to Count" Operation



GM TUBE WAVEFORMS

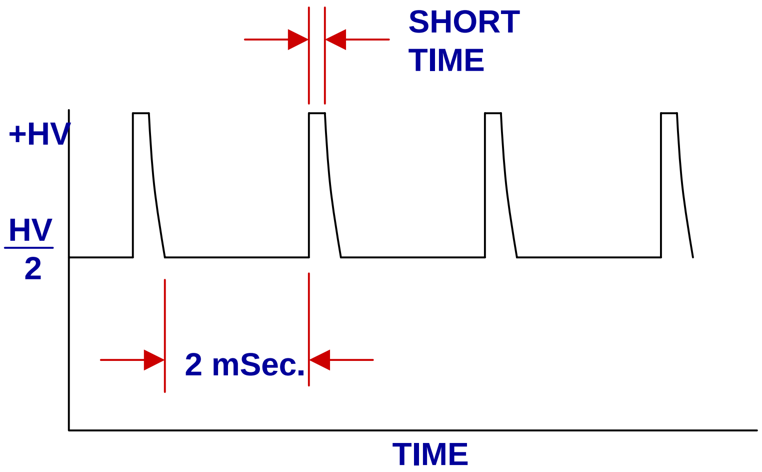


$$\text{RATE} = \frac{K}{\text{TIME TO COUNT}}$$

OPERATING PRINCIPLES – OPERATIONAL KIT

"Time to Count" Operation

HIGH FIELD



LOW FIELD