FLUKE®

Biomedical

10100AT, 10500AT & 10500AMT

TRIAD™ TnT X-Ray Field Service/Calibration/QA Kit

Technical Data

The TRIAD™ TnT X-Ray Field Service/Calibration/QA Kit is a full-function, x-ray dosimeter kit that performs fast, highly sensitive measurements. It is ideal for government compliance testing, troubleshooting, repair of diagnostic x-ray equipment, installation and setup of new equipment, preventive maintenance, radiographic QA measurements, and measurements required for JCAHO accreditation. The kit performs measurements for all modalities: radiographic, fluoroscopic, mammographic (MQSA), CT, cine and dental.

The TRIAD TnT Kit comes in three popular configurations:

- 10100AT is the base-level dosimeter kit and features the 35050AT dosimeter, a technologically advanced, microprocessor-controlled, x-ray radiation dosimeter. The kit also includes ion chambers and test stand, triaxial/coaxial cable, AC adapter, HVL filter set, RS232 interface cable with adapters, customization software, instruction manual CD, and lightweight carrying case.
- 10500AT includes all of the components from the 10100AT, in addition to the 35080M non-invasive kVp divider and 37617 wide-range filter pack (50 kVp to 150 kVp), for quick and accurate kV measurement.
- 10500AMT is equipped with all the components from the 10500AT, as well as the 35035 mA/mAs meter and CA-23 universal test-lead kit, allowing engineers to accurately measure mAs and fluoroscopic mA for diagnostic, radiographic, and fluoroscopic imaging equipment.

The TRIAD TnT incorporates the latest design innovations to enhance ease-of-use, range of applications, and save valuable time. TRIAD TnT continues the TRIAD tradition as the most accurate, widely used instrument of its kind available.

Key Features

- Bright display with direct readout in user-selected units
- Image intensifier measurements at 0.1 µR and 0.1 µR/s resolution; cine in µR/frame
- Expanded kVp and exposure-time measurement capabilities
- Simplified controls include autoreset, autoranging, automatic offset and drift compensation, automatic power-down, and automatic pressure and temperature correction
- Optional TRIAD toolkit for Excel for remote operation, waveform capture, and calibration
- Multiple self-checking features to reduce testing time
- Battery-powered with auto power-down feature to extend battery life
- Automatic temperature and pressure correction for faster operation in any environment
- Timesaving scroll functionality
- Recognizes and ignores spurious background signals
- Very low dose rate: 20 nGy/s at a 1 nGy/s resolution
- Broader range of dental unit kV and time measurement

96020C and 96035B Diagnostic Ion Chambers

The 96020C and 96035B Diagnostic Ion Chambers are vented-volume, parallel-plate air ionization chambers with side-mounted BNC triaxial connectors. The 96020C Ion Chamber has a nominal volume of 150 cm^3, and the 96035B has a nominal volume of 15 cm^3. Both ion chambers have a fully-guarded, centrally-located collector plate that provides superior collection efficiency.

The patented* 96035B has a dual-energy range that enables both diagnostic and mammographic measurements. They are accomplished using the other side as the entrance window.

Key Features

- Very low leakage and low noise
- Rugged mechanical construction
- Ionization chambers are supplied with triaxial BNC connectors

**** Patent numbers 4,843,619, 4,916,727 and 5,508,526.***

35080M Non-Invasive kVp Divider

The 35080M Non-Invasive kVp Divider quickly and accurately measures kV for all modalities. The unit checks both above and below table tubes, and the direct kV values are displayed on either the 35050AT Dosimeter or the 199XRAY Medical ScopeMeter. Derived kV can also be calculated using a storage oscilloscope. The 35080M Non-Invasive kVp Divider is highly portable and eliminates the need for bulky and heavy high-voltage divider tanks – so compact in size that it fits into a shirt pocket.

A patented* wide-range filter pack is included with the 35080M Non-Invasive kVp Divider and provides accurate readings for the range of 50 kVp to 150 kVp. Four optional filter packs are available for use with the 35080M Non-Invasive kVp Divider for CT, mammographic, and mobile applications.

Key Features

- New pocket-size configuration
- Non-invasive technology eliminates the hazards of high-voltage cables and need for bulky divider tanks
- Auto ON/OFF when connected/disconnected
- Optional filter packs enable testing in all modalities
- Rh/Rh measurement capability when 35080M Non-Invasive kVp Divider is used with cadmium K-Edge and linear mammo filter pack pair

35035 Digital mA/mAs Meter

The 35035 Digital mA/mAs Meter is a versatile instrument that is used by x-ray service engineers, field service engineers, and biomedical engineers to accurately measure mAs and fluoroscopic mA accurately for diagnostic, radiographic, and fluoroscopic imaging equipment. The 35035 Digital mA/mAs Meter operates with one, easily replaceable 9-volt alkaline battery, facilitating convenience and portability.

Technical Specifications
10100AT TRIAD TnT Kit

Exposure and Exposure Rate Accuracy
Basic accuracy of 35050AT: ± 1 % of reading ± 2 range resolution steps over range of 18 °C to 28 °C and ± 2 % of reading ± 2 range resolution steps over the full operating temperature range of 0 °C to 50 °C
Note: A 3 % NIST-traceable calibration is provided with each system and includes effects of 35050AT, 96035B, and 96020C.

Exposure Time Measurement
Exposure Time Accuracy: ± 0.1 % of reading ± 0.2 msec
Maximum Exposure Time: 6.5 s
Measurement Resolution: 0.2 ms

Measurement Modes
kVp/Dose/Time: Single-shot ("all-in-one" exposure), direct-beam measurement of exposure, kVp, and time; autoranging across three-decade ranges; auto reset between exposures; display updates after each exposure
kVp/Rate: Simultaneous measurement of kVp and exposure rate
Full Sensitivity Dose: Autoranging across five decades of sensitive ranges; automatic drift and offset compensation; automatic post-exposure display hold
Full Sensitivity Rate: Measurement range covers a span from low-level image intensifier measurements to unattenuated, direct beams; automatic offset compensation and nonlinear filtering. Autoranging provides five decades of sensitivity ranges. Display updates once per second.

Very Low Dose Rate (VLDR)
This mode is only for making very low dose rate measurements. Nonlinear digital filtering and autoranging provide five decades of sensitivity ranges. Display updates once per second. In this mode, automatic current offset and drift compensation are disabled. As a result, the system can display very low dose rates.

Power Requirements
Battery Life: ~30 hours with six AA alkaline batteries; automatic power-down after user-selected period of unattended operation (5 min to 255 min); AC adapter supplied with each 35050AT

Note: When the AC adapter is in use, the auto power-down feature is disabled, providing continuous operation. User selections for ion chamber, units, kV filter pack, temperature, pressure, and frame are stored in nonvolatile memory before automatic turnoff; eliminates manual reselection at power-up.
Bias Voltage Supply: Fixed electronic bias (~300 V); bias voltage removed from triaxial input connector at instrument turnoff
Customization: Allows user to modify contents of nonvolatile memory, including ion chamber and kV filter pack conversion factors, temperature and pressure units, radiation units, and power down interval. A field customization software program is included for use with an IBM®-PC or compatible.

Ion Chamber	Units	Effective Range ***	Resolution Step Size
15 cc	R	100 µ to 20 µ	1 µ
	R/s	100 µ to 20 µ	1 µ
	R/m	5 m to 1200 m	50 µ
	R/h	100 m 72 k	1 m
	R/f **	2 µ to 333 m	0.02 µ
	Gy	1 µ to 175 m	0.01 µ
	Gy/s	1 µ 174 m	0.01 µ
	Gy/m	50 µ to 10.5 µ	0.5 µ
	Gy/h	1 m to 630 m	0.01 µ
	Gy/f **	0.02 µ to 2.9 m	0.2 µ
150 cc	R	10 µ to 2 µ	0.1 µ
	R/s	10 to 2 µ	0.1 µ
	R/m	0.5 m to 120 m	5 µ
	R/h	10 m to 7.2 k	0.1 m
	R/f **	0.2 µ to 33 m	0.002 µ
	Gy	0.1 µ to 17.5 m	0.001 µ
	Gy/s	0.1 µ to 17.5 m	0.001 µ
	Gy/m	5 µ to 1050 m	.05 µ
	Gy/h	0.1 m to 63 m	0.001 m
	Gy/f **	0.002 µ to 290 µ	0.02 n
150 cc VLDR	R/s	2 µ to 2*	0.1 µ
	R/m	0.1 m to 120*	5 µ
	R/h	2 m to 7.2 k*	0.1 m
	R/f **	0.04 µ to 33 m*	0.002 µ
	Gy/s	0.02 µ to 17.5 m*	0.001 µ
	Gy/m	1 µ to 1050 m*	0.05 µ
	Gy/h	0.02 m to 63 m*	0.001 m
	Gy/f **	0.4 n to 290 µ*	0.02 n
Electrical Units	C	1 p to 100 n	0.01 p
	A	1 p to 100 n	0.01 p

Values for ion chambers are calculated using nominal sensitivities: 15 cc: 2.4 x 10^8 R/C, 150 cc: 2.4 x 10^7 R/C
*Very Low Dose Rate effective range at 5 % resolution steps. **At 60 f/s (1 to 120 frames/selectable).
***IEC 61674 effective range at 1 % resolution steps

Connections
35080M Interface: Male, two lug BNC
Computer Interface: RS232, using RJ-45 connector; 9,600 baud 8-bit, 1 stop, no parity, xon/xoff; enables fully-programmable operation and waveform display from a PC with optional Excel add-in; powered when connected to computer
Ion Chamber Input: Triax, BNC; collector and guard positive-biased relative to ion chamber body and dosimeter chassis
Power: 2.1 mm DC power jack, power input for an unregulated 9 V, 200 mA adapter with a center negative, 2.1 mm plug

General Information
Display: Two-line, 20-character alphanumeric PLED (polymer LED), with 0.5 cm character height; indicates all ion chamber/kV filter pack identification information, numerical measurement results, battery level, calibration date and other information
Weight: 14 lb (6.4 kg)
Optional Accessories
USB to RS232 adapter (38617)

Accessories Supplied
Test Stand (37581): Machined stainless steel upright rod with base, ion chamber holder, and tray for HVL filters, which includes one ion chamber stem
Programming Kit (37594): Includes customization software on CD, IBM-PC format and 6.5 ft (2 m)
RS232 interface cable with adapters for PC-type and AT-type computers
Instruction Manual (35050ATCD): 10100AT TRIAD Field Service Kit Operator's Instruction Manual on CD
Cable (38208): 20 ft (6 m) coax/triax cable
AC Adapter: 9 V, 200 mA, DC
HVL filter Set (37668): Set of 12 aluminum filters for half-value layer measurements, which includes one 2 mm, two 1 mm, two 0.5 mm, three 0.1 mm, one 0.2 mm and three 0.05 mm
Kit Carrying Case (37500D): High-density polyethylene (HDPE) plastic absorbs impact to protect contents. Custom-cut, high-quality

(Technical Specs continued on next page)

**** Patent numbers 4,843,619, 4,916,727 and 5,508,526.***

(continued from previous page)

foam interiors surround and protect standard kit equipment and accessories.

Dimensions
18 in L x 13 in W x 6 in H
(46 cm L x 33 cm W x 15 cm H)

Diagnostic Ionization Chambers (96035B and 96020C)
Energy Range
96035B: 30 kVp to 150 kVp; 20 kVp to 50 kVp for mammographic 96020C: 30 kVp to 150 kVp
Nominal sensitivity
96035B: 2.00 R/C x 10^8 R/C (1.75 Gy/C x 10^6 Gy/C) at 22 °C and 1013 hPa 2.21 R/C x 10^8 R/C (1.94 Gy/C x 10^6 Gy/C) at 22 °C and 1013 hPa (flat response suitable for conventional diagnostic radiography and mammography)
96020C: 2.08 R/C x 10^7 R/C (1.82 Gy/C x 10^5 Gy/C) at 22 °C and 1013 hPa (optimized for low-level image intensifier and cine measurements)
Construction
96035B: Graphite-coated acrylic, parallel-plate, air-vented
96020C: Composite graphite-filled thermoplastic; parallel-plate, air-vented
Volume
96035B: 15 cm^3
96020C: 150 cm^3

Technical Specifications

96020C and 96035B Diagnostic Ion Chambers

Energy Range
96020C: 30 kVp to 150 kVp
96035B: 30 kVp to 150 kVp for diagnostic measurements; 20 kVp to 50 kVp for mammographic measurements

Nominal Volume
96020C: 150 cm^3; 11.30 cm diameter by 1.50 cm thick active volume
96035B: 15 cm^3; 3.96 cm diameter by 1.22 cm thick active volume

Nominal Sensitivity
96020C: H60: 2.08 R/C x 10^7 R/C at 22 °C and 760 mmHg (optimized for low-level image intensifier and cine measurements)
96035B: L100: 2.0 R/C x 10^8 R/C at 22 °C and 760 mmHg
MV30 (PTB Mammo Point): 2.21 R/C x 10^8 R/C at 22 °C and 760 mmHg (flat energy response suitable for conventional diagnostic radiography and mammography)

Leakage Current
< 10 fA under normal bias conditions (300 V)

Collection Efficiency
96020C: 95 % at 2,000 R/min
96035B: 95 % at 5,000 R/min

Wall Material
96020C: Composite graphite-filled thermoplastic
96035B: Graphite-coated acrylic (methyl-methacrylate)

Window Material
96020C: 0.76 mm thick, graphite-coated polycarbonate
96035B: Both entrance windows are made of 0.25 mm graphite-coated polycarbonate

Window Density
96020C: 91 mg/cm^2
96035B: 32 mg/cm^2

Active Window Area
96020C: 100 cm^2, centered within the chamber body
96035B: Each side of the chamber has a circular active window region centered 7.1 mm further from the BNC connector than the center of the chamber body; active window regions have an area of 12.32 cm^2

Collector Plate
96020C: 0.8 mm thick graphite-coated acrylic plate, 10.80 cm in diameter; 2.16 cm x 2.85 cm guard region electrically isolated from collector area
96035B: 0.25 mm thick, centrally mounted, graphite-coated, polycarbonate plate, 3.18 cm, ± 0.01 cm in diameter; 1.27 cm x 0.89 cm guard region is electrically isolated from the collector area

Connector
Side-mounted, triaxial, two-lug BNC connector

Calibration
96020C Standard Calibration: Standard calibration performed at H60 (NIST defined as 60 kVp, first HVL of 6.0 mm Al, homogeneity coefficient of 94)
96035B Standard Calibration: Standard calibration performed at one diagnostic and one mammographic beam quality; calibration factors normalized to 22 °C and 760 mmHg
Diagnostic Unattenuated Beam: Calibration on diagnostic side of chamber is performed at M80 (NIST defined as 80 kVp, first HVL of 2.97 mm Al, homogeneity coefficient of 57)
Mammographic Beam: Calibration on mammographic side performed at Mo/Mo28 (NIST defined as 28 kVp, first HVL of 0.332 mm Al, homogeneity coefficient of 74.3) or MV30 (PTB defined as 30 kVp, first HVL of 0.337 mm Al)

Technical Specifications 35080M Non-Invasive kVp Divider

Range
50 kVp to150 kVp, using only the wide-range radiographic filter pack (37617); range and versatility extended with use of special optional filter packs

Accuracy
± 2 % of reading in the range of 50 kVp to 150 kVp, exclusive of linearity, filtration, and gain effects; linearity corrections automatically applied when using 35080M Non-invasive kVp Divider with either the 35050AT Dosimeter or the 199XRAY Medical Scopemeter

Response Time
150 µs (10 % to 90 %)

Calibration
Internally generated signal provides calibration check

Minimum Time for Valid Reading
1 ms, 3-phase; one line cycle, single-phase

Tube Current
Wide Dynamic Range: From 4 mA to 3000 mA (3-phase), 2 mA to 1500 mA (single-phase)
Note: Generator settings will vary in waveform and distance. Less than ± 1 kV effect for wide-range radiographic filter pack, covering 50 kVp to 150 kVp. Specialty filter packs may have different characteristics

CT Filter Pack – 33551 (Optional Accessories)
Provides precision measurements in the 70 kVp to 140 kVp range with an accuracy of ± 2 %. Active area is just 3.8 cm x 0.48 cm, to accommodate the narrow beam of most scanners.

Cadmium K-Edge and Linear Mammo Filter Pack Pair – 37351/37355 (Optional Accessories)
Cadmium k-edge mammo pack uses the inherent stability of the cadmium k-edge as an absolute reference for precision measurements between 27.5 kVp and 29.5 kVp with ± 0.5 kV accuracy; use linear mammo pack with the cadmium k-edge mammo pack for precision calibrations of ± 1.0 kV accuracy from 22 kVp to 40 kVp

Mobile Filter Pack – 37946 (Optional Accessories)
Easily and accurately measures kV on mid-frequency generators (> 1 kHz) with substantial kV ripple (> 8 %); provides precision measurements in the range of 50 kVp to 135 kVp with accuracy of ± 2 %

Low Range Filter Pack – 38237 (Optional Accessories)
Provides precision measurements in the 30 kVp to 90 kVp range with an accuracy of ± 2 % (for radiographic generators using tungsten target)

Environmental Requirements
Temperature Range: 0 °C to 35 °C
Relative Humidity: 20 % to 80 %
Storage Temperature: –35 °C to 50 °C

General Information
Orientation: Long axis of the 35080M Non-invasive kVp Divider oriented perpendicular to axis of x-ray tube to eliminate heel effect
Power requirements: 9 V battery, 50 hours operation; battery-check function connects battery to output terminals for voltage measurement
Dimensions: 2.375 in L x 3.5 in W x 8.25 in H (6.0 cm L x 9.0 W cm x 21 cm H)
Weight: 1.50 lb (0.68 kg)

Technical Specifications 35035 mA/mAs Meter

Controls
1) Power mA/mAs switch, 2) Reset switch, 3) Range switch: 200 mA/mAs, 2000 mA/mAs and 20 mA range settings, 4) AC/DC switch

Accuracy
1 % of reading ± two least significant digits for all ranges

Environmental Requirements
Temperature Range: 5 °C to 35 °C
Relative Humidity: 0 % to 80 %
Storage Temperature: –20 °C to 50 °C

General Information
Display: Liquid crystal display (LCD), 3.5 digit, .5 in H (13 mm)
Input: Two banana jacks
Power requirements: 9 V alkaline battery with easy replacement
Dimensions: 2 in L x 2 in W x 3.50 in H (15 cm L x 5.0 cm W x 8.75 cm H)
Weight: .78 lb (.35 kg)

Please refer to charts at the right for Miliamp, Current and Signal Input limit specifications for the 35035 mA/mAs Meter

Milliamp Seconds (mAS)		
Range	Resolution	Input impedance*
200 mAs	0.1 mAs	10 Ω
2000 mAs	1.0 mAs	1 Ω

* Does not include fuse resistance. Also, does not include effect of bridge rectifier present when unit is set for AC Specifications

Current (mA)		
Range	Resolution	Input impedance*
20 mA	0.01 mA	100 Ω
200 mA	0.1 mA	10 Ω
2000 mA	1 mA	1 Ω

* Does not include fuse resistance. Also, does not include effect of bridge rectifier present when unit is set for AC Specifications

Signal Input Limits		
Function	Range	Max Input Limit
mA	OFF	Input Shorted; 2.0 A maximum (fuse protected)
	20	250 mA for 30 s*
	200	1.0 A fir 30 s*
	2000	2.0 A maximum (fuse protected)
mAs	200	1.0 A for 30 s*
	2000	2.0 A maximum (fuse protected)

* Limits set by power dissipation rating of shunt resistors.

Ordering Information

Model

10100AT: TRIAD TnT Dosimeter Kit includes:
- 35050AT: Dosimeter
- 96035B: 15 cm^3 Ion Chamber
- 96020C:150 cm^3 Ion Chamber
- 38208: Coax/triaxial cable, 20 ft (6 m)
- 37594: Programming kit (37594), includes customization software on CD, two-meter RS232 interface cable and adapters
- 37581: Test stand (37581), ion chamber stem, HVL filter tray
- 37688: HVL filter set (37668)
- 14-106(US): AC adapter, 9 V, 200 mA, DC [14- 107(EU), 14-108(UK), 14-109(AS)]
- 35050ATCD: User/service manual
- 37500D: Kit carrying case

10500AT: TRIAD TnT X-Ray Field Kit Service/Calibration/QA Kit includes:
- (Components in 10100AT Kit)
- 35080M: Non-Invasive kVp Divider
- 37617: Wide-range filter pack (50 kVp to 150 kVp)

10500AMT: TRIAD TnT X-Ray Field Kit Service/Calibration/QA Kit includes:
- (Components in 10500AT Kit)
- 35035: mA/mAs Meter
- CA-23: Universal test lead kit

Optional Accessories (All Kits)

500-100: CT Ion Chamber 3.2 cm^3

07-434: Ultra-high purity HVL attenuators (for mammo set of six)

10500EXL: TRIAD toolkit for Excel

38617: USB to RS232 adapter

199XRAY: Medical ScopeMeter with kVp capabilities (includes the MA190 Medical ScopeMeter accessory kit)

Optional Accessories (10500AT and 10500AMT Kits)

37355/37351: Mammographic filter pack pair includes: Cadmium k-edge mammo filter pack (27.5 kVp to 29.5 kVp) ± 0.5 kV accuracy, linear mammo filter pack (22 kVp to 40 kVp) ± 1.0 kV accuracy Note: Mammo filter packs are designed for molybdenum anode, beryllium window generators.

37946: Mobile filter pack (50 kVp to 135 kVp) ± 2 % accuracy

33551: CT filter pack (70 kVp to 140 kVp) ± 2 % accuracy kVp) ± 2 % accuracy

About Fluke Biomedical

Fluke Biomedical is the world's leading manufacturer of quality biomedical test and simulation products. In addition, Fluke Biomedical provides the latest medical imaging and oncology quality-assurance solutions for regulatory compliance.

Today, biomedical personnel must meet the increasing regulatory pressures, higher quality standards, and rapid technological growth, while performing their work faster and more efficiently than ever. Fluke Biomedical provides a diverse range of software and hardware tools to meet today's challenges.

Fluke Biomedical Regulatory Commitment

As a medical device manufacturer, we recognize and follow certain quality standards and certifications when developing our products. We are ISO 9001 certified and our products are:
- FDA Compliant
- CE Certified, where required
- NIST Traceable and Calibrated
- UL, CSA, ETL Certified, where required
- NRC Compliant, where required

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