ELECTRONICS TEST CENTRE
MPB TECHNOLOGIES INC.
Unit 100, 302 Legget Drive
Ottawa, Ontario, K2K 1Y5
Canada

Taser Model M26
Test Concepts

Prepared By:

Ian P.W. Sinclair, PhD
MPB Technologies Inc.
Pointe-Claire, Québec, Canada

Issue Date: January 22, 2009
Revision: 4

Report Composition: Pages 1 to 16

Industry Canada Industrie Canada

ISO/IEC 17025

© 2009 MPB Technologies- Electronics Test Centre

TABLE OF CONTENTS

© 2009 MPB Technologies- Electronics Test Centre

1 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to establish definitions for measurement of the pulse of the Taser M26, and to outline proposed tests to be conducted at ETC.

1.2 SCOPE

The scope of the document is limited to ideas and concepts of tests that can be run to establish the operational status of Taser M26 models.

1.3 REVISION STATUS

Revision	Date Issued	Reason for Issue / Re-Issue
1	January 9, 2009	Draft 1
2	January 19, 2009	Draft 2
3	January 20, 2009	Draft 3
4	January 26, 2009	Final

1.4 APPLICABLE DOCUMENTS

1.4.1 Government documents

1.4.2 Non – government documents

X26 Factory Specification and Test Procedure, Version 4.0. Taser International.

Customer Testing of Taser X26 and Advanced Taser M26, January 19,2009. Letter from Magne Nerheim, VP R&D, Taser International.

1.4.3 Company documents

© 2009 MPB Technologies- Electronics Test Centre

2 SPECIFICATIONS

2.1 OFFICIAL TASER M26 SPECIFICATION

A one-page spec sheet for the device may be found at
http://www.taser.com/SiteCollectionDocuments/Controlled%20Documents/Spec%20Sheets/Law%20Enforcement/RD-SPEC-M26-001_K.pdf
The following extracts from the official specifications were turned into Table 1.

Output characteristics:
Wave form: Damped oscillation /"blunt" pulse with 17 μs decay time constant.
Pulse rate:
20 PPS ± 25% with NiMH rechargeable cells
15 PPS ± 25% with alkaline cells
Pulse duration: 40 microseconds full waveform 10 microseconds primary phase
The trigger activates a 5-second cycle. The cycle can be stopped by placing the safety lever in the safe position.
Peak open circuit arcing voltage: 50,000 V
Peak loaded voltage: 5,000 V, avg. voltage over duration of main phase 3400 V, avg. over full phase 320 V, avg. over one second 1.3 V.
Current: 3.6 mA average
Energy per pulse:
Nominal at main capacitor: 1.76 joules
Delivered into load: 0.50 joules
Power rating:
Nominal at main capacitor: 26 watts at 15 PPS
Nominal delivered into load: 7.39 watts at 15 PPS

TABLE 1: M26 OUTPUT CHARACTERISTICS

Item	Value
Waveform:	Damped oscillation with 17 μsec decay constant
Pulse rate:	20 ± 5 pulses per second (PPS) NiMH battery 15 ± 4 pulses per second (PPS) Alkalne cells
Pulse duration, full waveform	40 microseconds
Pulse duration, primary phase	10 microseconds
Cycle length:	5 seconds
Peak open circuit arcing voltage:	50,000 V
Peak loaded voltage	5,000 V
Avg. voltage over duration of main phase	3400 V
Avg. voltage over full phase	320 V
Avg. voltage over one second	1.3 V
Avg. Current	3.6 mA
Energy per pulse at main capacitor	1.76 joules
Energy per pulse delivered into load:	0.50 joules
Power rating at main capacitor	26 watts at 15 pps
Power rating delivered into load:	7.39 watts at 15 pps

© 2009 MPB Technologies- Electronics Test Centre

2.2 TASER M26 SPECIFICATION UPDATES

From a letter to H.D.M. Madill dated December 15, 2008 from Magne (Max) Nerheim, Vice President Research and Development, Taser International.

Specifications are provided for two battery types, both into 250-Ohm loads.

TABLE 2: M26 OUTPUT CHARACTERISTICS (NIMH BATTERY)

Item	Value
Main Phase Charge	80 – 115 microcoulombs
Net Charge	30 – 75 microcoulombs
Pulse Duration (main phase)	7 – 11 microseconds
Pulse Duration (total)	35 – 55 microseconds
Pulse Rate (pps)	20 ± 25% pulses per second
Average Main Phase Current (Main phase charge * pps)	1.2 – 2.9 mA
Main Phase Peak Current	15.6 – 20.4 A
Peak Loaded Voltage	3900 – 5100 Volts

TABLE 3: M26 OUTPUT CHARACTERISTICS (ALKALINE BATTERY)

Item	Value
Main Phase Charge	80 – 115 microcoulombs
Net Charge	30 – 75 microcoulombs
Pulse Duration (main phase)	7 – 11 microseconds
Pulse Duration (total)	35 – 55 microseconds
Pulse Rate (pps)	15 ± 25% pulses per second
Average Main Phase Current (Main phase charge * pps)	0.9 – 2.1 mA
Main Phase Peak Current	15.6 – 20.4 A
Peak Loaded Voltage	3900 – 5100 Volts

© 2009 MPB Technologies- Electronics Test Centre

From a note dated January 19, 2009 from Magne (Max) Nerheim, Vice President Research and Development, Taser International (TI).

Separate specifications for customer testing are provided, in order to account for variations in test setups and testing temperature and humidity conditions.

The test load is 250 Ohms. The particular resistive load used by TI is an Ohmite Model LN100J250 250-ohm non-inductive resistor.

A test load of 500 Ohms may be more representative of the impedance presented by the human body to voltage levels typical of the M26. Taser International may provide specifications for tests conducted using this impedance at a later date. Tests made at 250 Ohms are considered authentic in showing the correct operation of the device.

Specifications for pulse rate and average main phase current are provided for two battery types, alkaline and Nickel-Metal-Hydride (NiMH).

TABLE 4: M26 OUTPUT CHARACTERISTICS (WITH CUSTOMER SPECS)

Item	**Factory: 250 Ω**	**Customer: 250 Ω**
Peak loaded voltage	3900-5100 volts	3700-5300 volts
Main Phase Charge	80–115 microcoulombs	75 –125 microcoulombs
Pulse rate: Alkaline	15 ± 25%	15 +30/-25%
Pulse rate: NiMH	20 ± 25%	20 +30/-25%
Pulse duration: Main Phase Pulse Duration	7-11 microseconds	7-12 microseconds
Pulse duration: total pulse duration	35-55 microseconds	32-60 microseconds
Net charge	30-75 microcoulombs	25-80 microcoulombs
Peak Current	15.6 – 20.4 A	14.8 – 21.2 A
Average Main Phase Current (Main Phase Charge * Pulse Rate): Alkaline	0.9 – 2.1 mA	0.9 – 2.3 mA
Average Main Phase Current (Main Phase Charge * Pulse Rate): NiMH	1.2 – 2.9 mA	1.2 – 3.1 mA

© 2009 MPB Technologies- Electronics Test Centre

3 TYPICAL PULSE WAVEFORM PLOTS

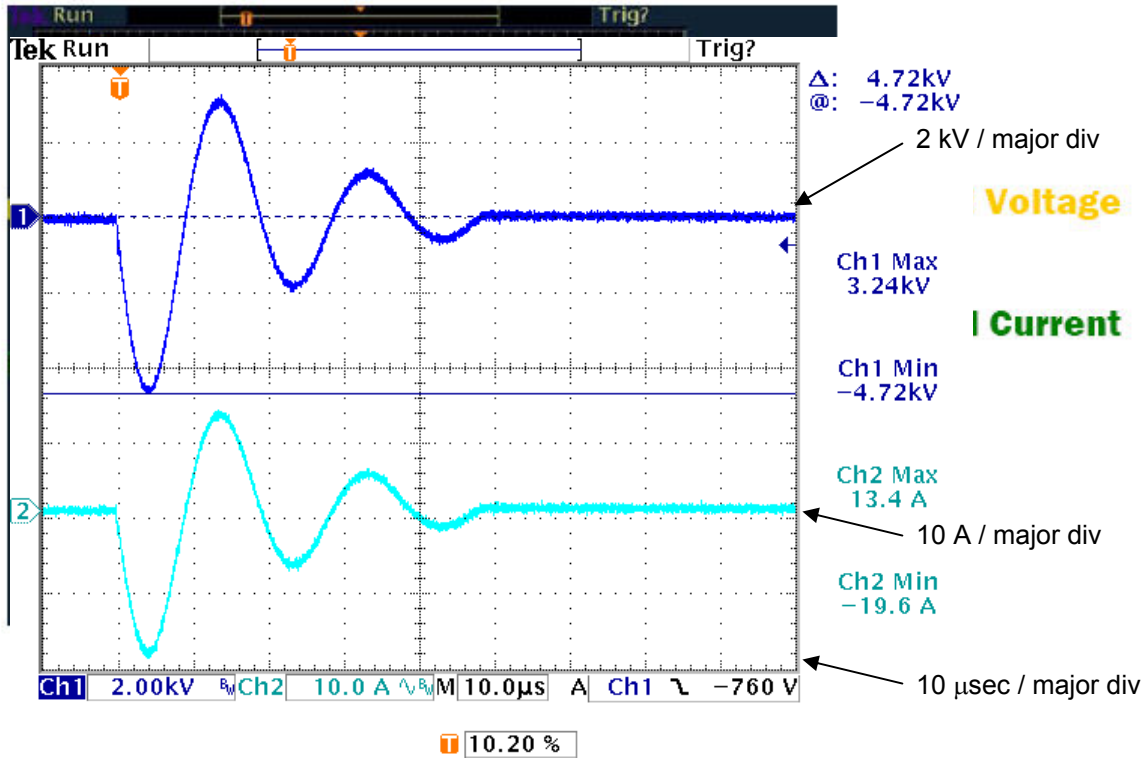


FIGURE 1: M-26 WAVEFORM INTO 250 Ω LOAD (FROM ETC REPORT R1R3645, P. 30)[1]

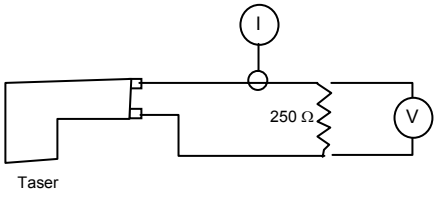


FIGURE 2: TEST SETUP

[1] Test Report: Load voltage, load current and open circuit voltage measurements on the X26 and M26 conducted energy weapons (CEW) in accordance with Taser International Test Procedure provided by the RCMP. Report R1R3645 Rev 6. Dec 11, 2008.

© 2009 MPB Technologies- Electronics Test Centre

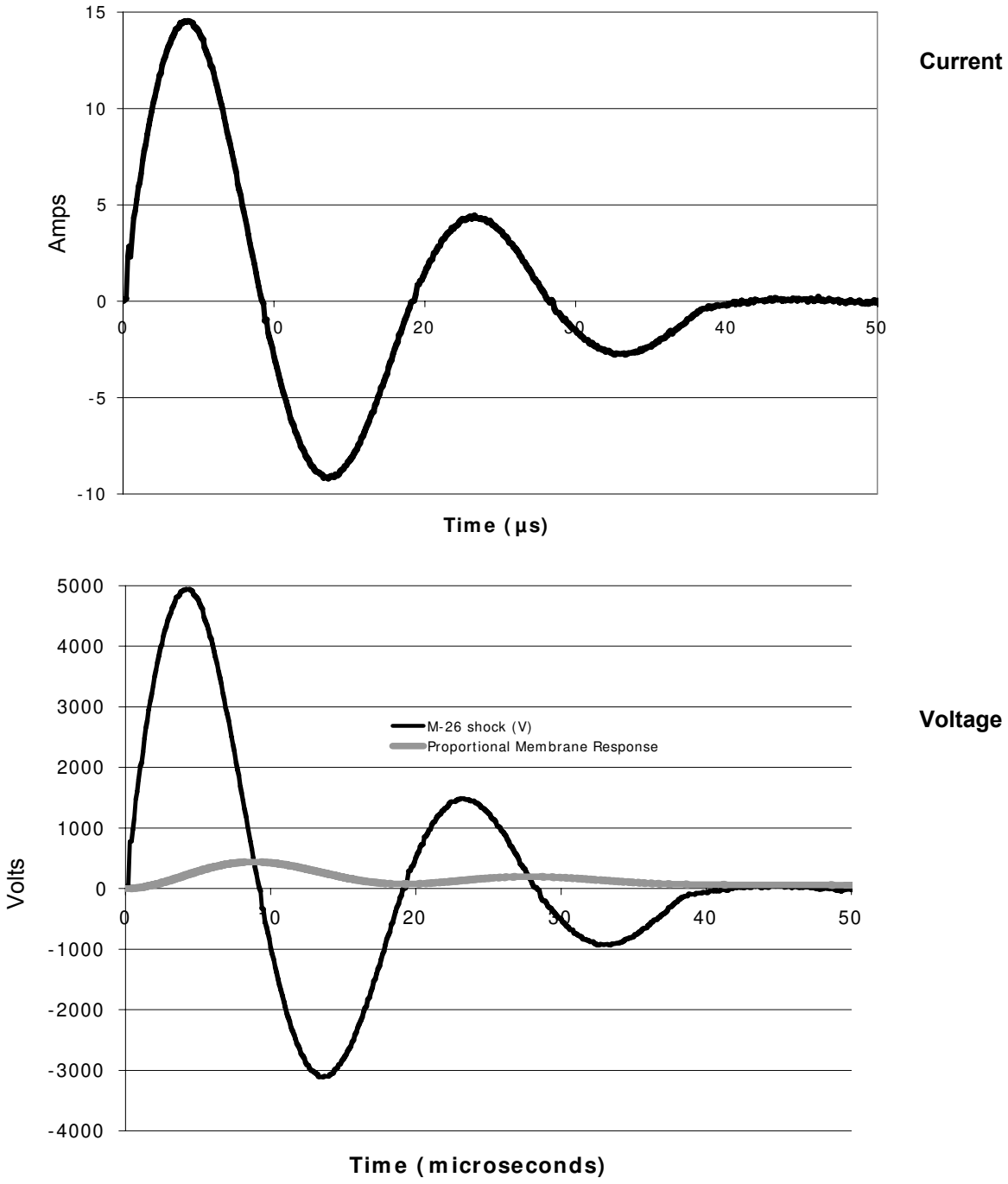


FIGURE 3: M26 WAVEFORMS INTO TYPICAL LOAD (M.W. KROLL)[2]

[2] Kroll, M.W. Educational Exhibits. Mark Kroll & Associates, Crystal Bay, MN. http://www.taser.com/research/Legal/Documents/Appendix%20B%20Educational%20Exhibits%20%20Kroll%20expert%20report.doc

© 2009 MPB Technologies- Electronics Test Centre

4 SUGGESTED ETC TESTS

TABLE 5: M26 TEST PARAMETERS

Parameter	Condition	Spec into 250 Ω Load
Main Phase Charge	Area under main phase current vs time curve, on a pulse averaged over 8 pulses	75 – 125 microcoulombs
Main Phase Pulse Duration	Between initial point of waveform[3] and first zero crossing, on a pulse averaged over 8 pulses	7 – 12 microseconds
Total Voltage Pulse Duration	Between initial point of waveform[3] and final point[4], on a pulse averaged over 8 pulses	32 – 60 microseconds
Pulse Rate (pps)	Average over at least 14 points - Alkaline battery - NiMH battery	 15 +5/-4 pulses per second 20 +6/-5 pulses per second
Average Current per second	Main phase charge × pulse rate - Alkaline battery - NiMH battery	 0.9 – 2.3 mA 1.2 – 3.1 mA
Main Phase Peak Current	Peak of absolute value of current, on a pulse averaged over 8 pulses	14.8 – 21.2 A
Peak Loaded Voltage	Peak of absolute value of voltage, on a pulse averaged over 8 pulses	3700 – 5300 Volts

- Taser International Customer Specifications have been applied (from Table 4).
- Load resistor is 250 Ohm non-inductive (spec will change to 500 Ohm when available from TI)
- Use expended cartridge for the tests; check contacts when changed to next test unit
  - Sparks jump across additional gaps when this part of the device is installed
- Carry out tests on a non-conductive surface
  - This simulates the actual conditions of deployment
- Raw trace data to be retained to permit further post-test analysis.
- Averaged measured values to include mean, variance, minimum and maximum
  - Averaging is over 8 consecutive pulses or over 8 highest pulses; discuss with customer
  - It's possible to choose the location of the 8 pulses or to average over all pulses in a cycle
- Spark test the unit before load testing
  - This conditions the internal spark gap
  - Some customers may prefer to skip the spark test; discuss with the customer
- Uncertainty calculations for instrumentation setup, as per ISO 2725.

[3] Initial point is first point in the pulse where absolute voltage reaches 50 V
[4] Final point is last point in the pulse where absolute voltage drops below 50 V

© 2009 MPB Technologies- Electronics Test Centre

5 WAVEFORM DEFINITIONS

The pulse consists of a damped oscillation with a 17 μsec time constant. The initial half sinusoid is known as the "main phase" as defined in Figure 4. The pulses are delivered in a "cycle" as shown in Figure 5. The cycle consists of about 75 pulses over 5 seconds, at the rate of 15 pulses per second if an alkaline battery is used. The cycle has 100 pulses at the rate of 20 pulses per second if a NiMH battery is used.

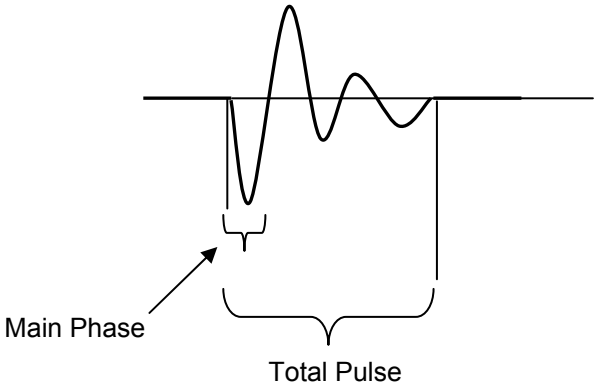


FIGURE 4: PULSE, CONSISTING OF ARC PHASE AND MAIN PHASE

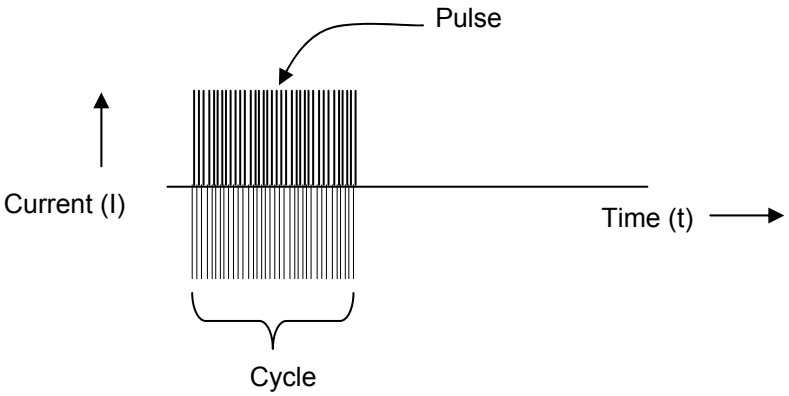


FIGURE 5: CYCLE OF APPROXIMATELY 75 OR 100 PULSES

© 2009 MPB Technologies- Electronics Test Centre

6 MEASURED PARAMETER DEFINITIONS

6.1 INTRODUCTION

Parameters of individual M26 pulses will be calculated as shown in Figure 6 to Figure 11. These describe, respectively,

- peak voltage (main phase)
- peak current (main phase)
- pulse charge (main phase)
- pulse duration (main phase),
- pulse duration (full pulse),
- pulse repetition rate.

Explanations

Information is derived primarily from the main phase, since this is the pulse that captures the motor neuron. It is 10 microseconds long, and delivers about 100 microcoulombs of charge in a single direction, whereas the remainder of the pulse about 100 microcoulombs spread over 40 microseconds in alternating negative and positive directions. The first pulse has the major physiological effect, while the remainder of the pulse has less effect, likely because of its current reversals at 10 microsecond intervals.

Illustrations use the M26 decaying sinusoid pulse waveform. The X26 waveform, a shaped pulse, is treated in a separate document.

A separate discussion of power rating and energy per pulse is provided on Page 16. This is not part of the proposed test procedure.

© 2009 MPB Technologies- Electronics Test Centre

6.2 PEAK CURRENT AND VOLTAGE

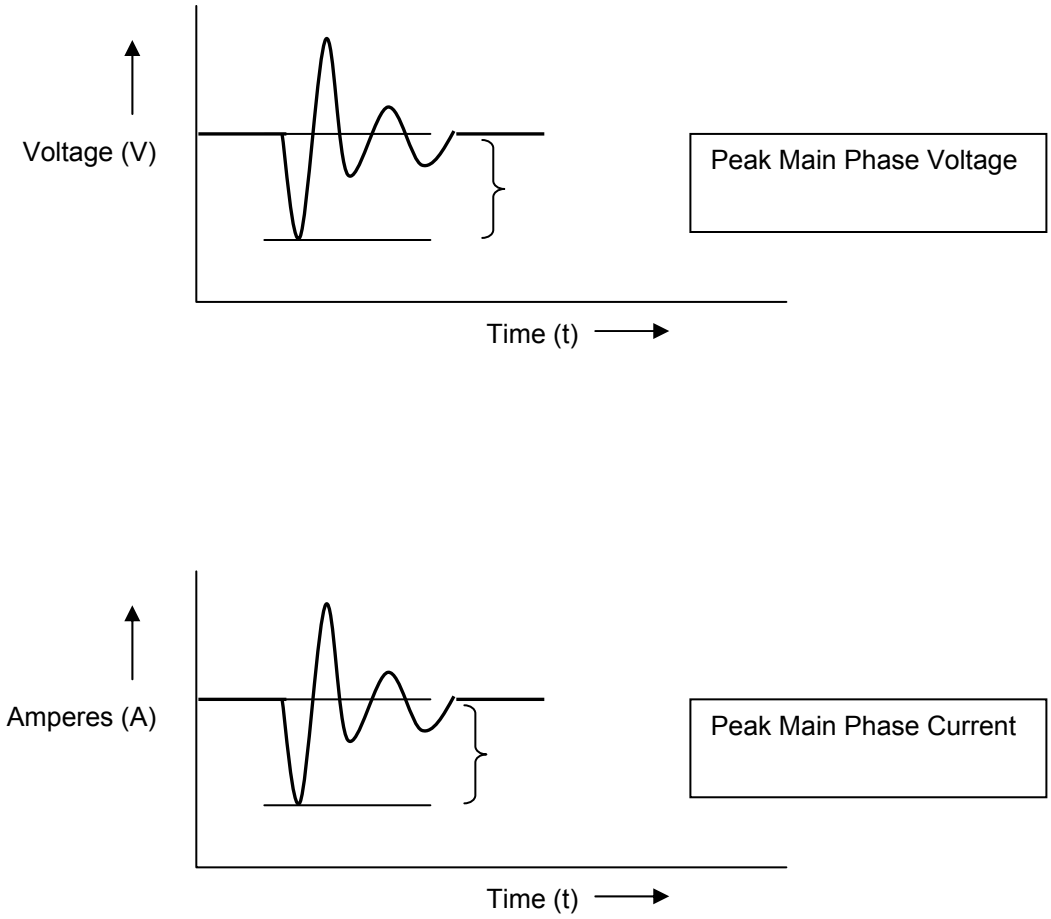


FIGURE 6: M26 PEAK MAIN PHASE CURRENT AND VOLTAGE

© 2009 MPB Technologies- Electronics Test Centre

6.3 PULSE CHARGE

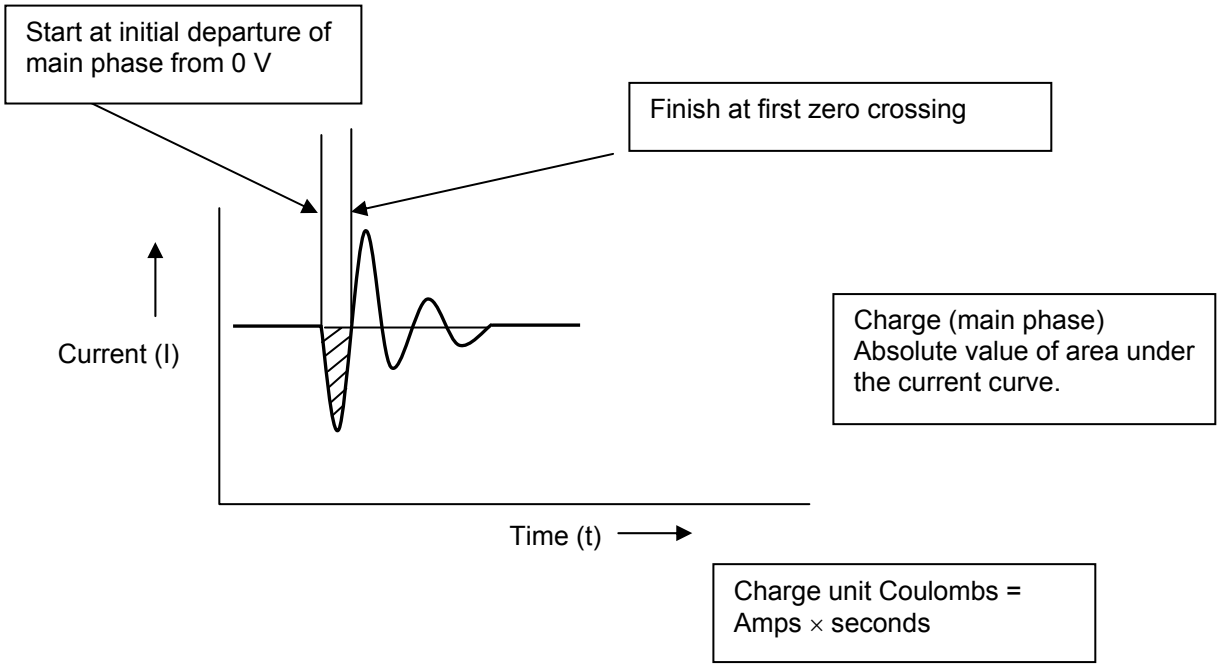


FIGURE 7: M26 MAIN PHASE CHARGE

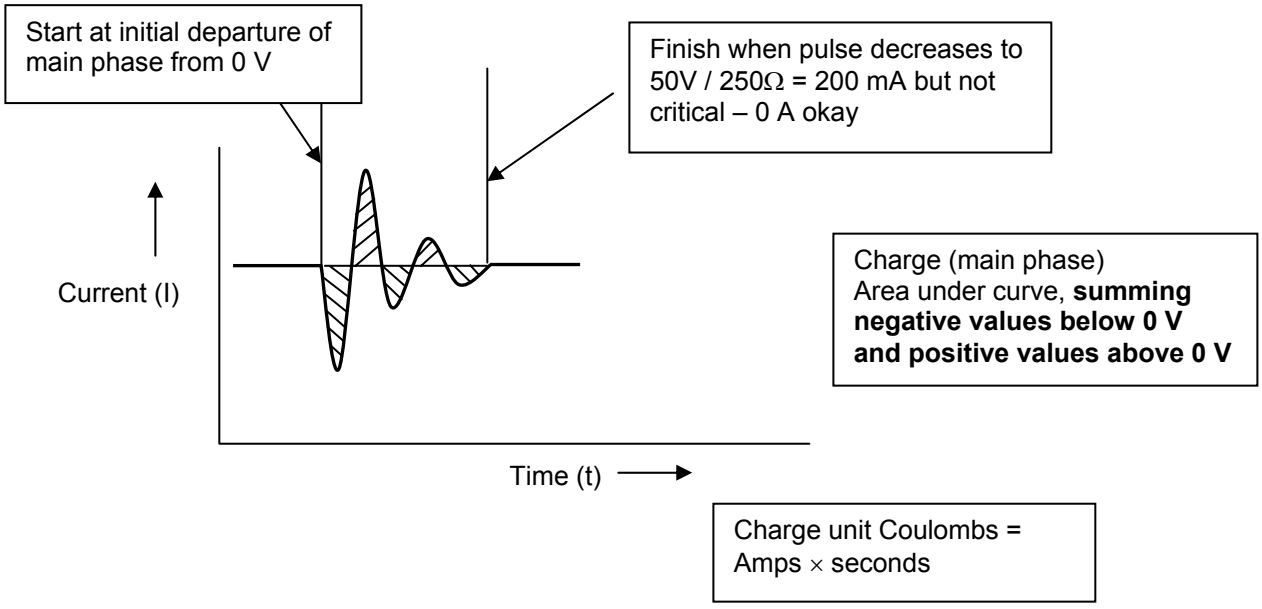


FIGURE 8: M26 NET CHARGE

© 2009 MPB Technologies- Electronics Test Centre

6.4 PULSE DURATION

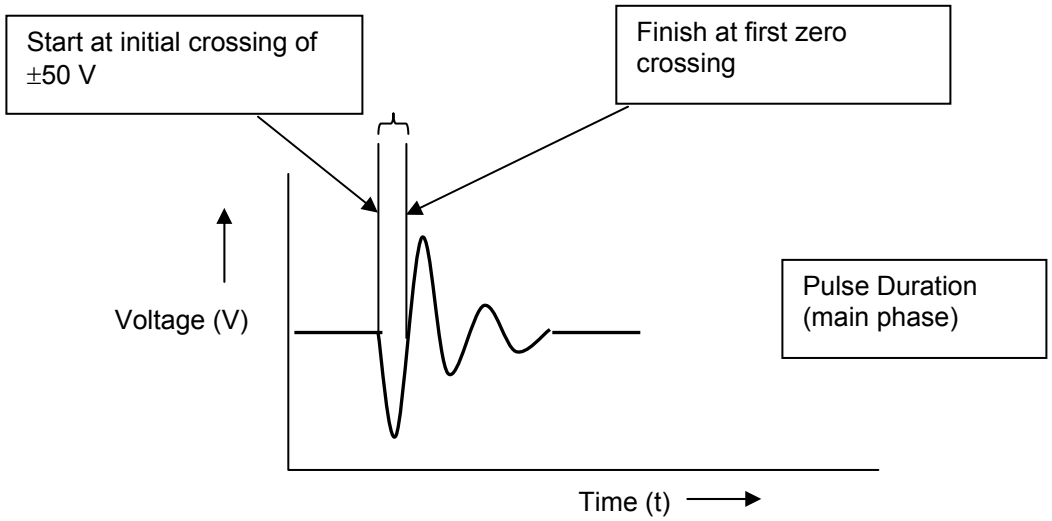


FIGURE 9: M26 MAIN PHASE PULSE DURATION

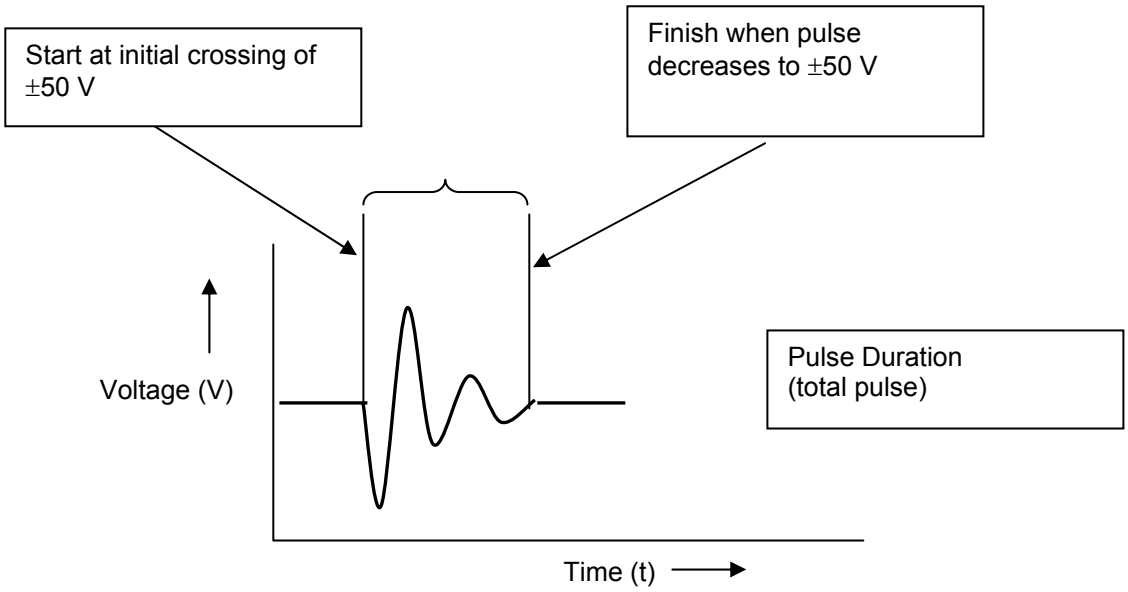
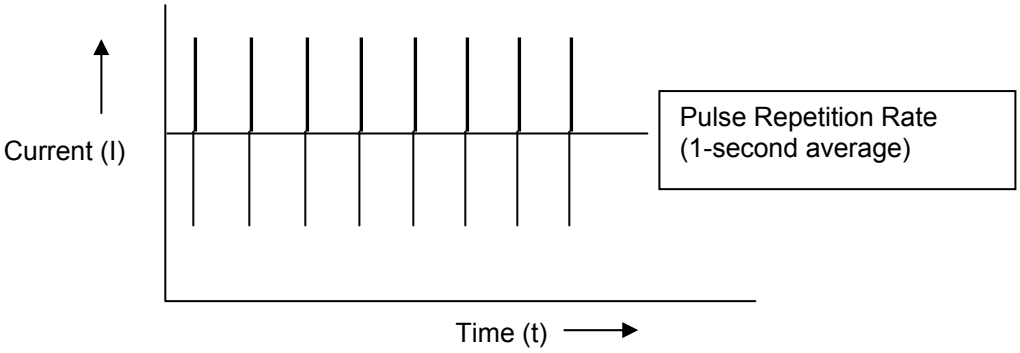


FIGURE 10: M26 TOTAL PULSE DURATION

© 2009 MPB Technologies- Electronics Test Centre

6.5 PULSE REPETITION RATE



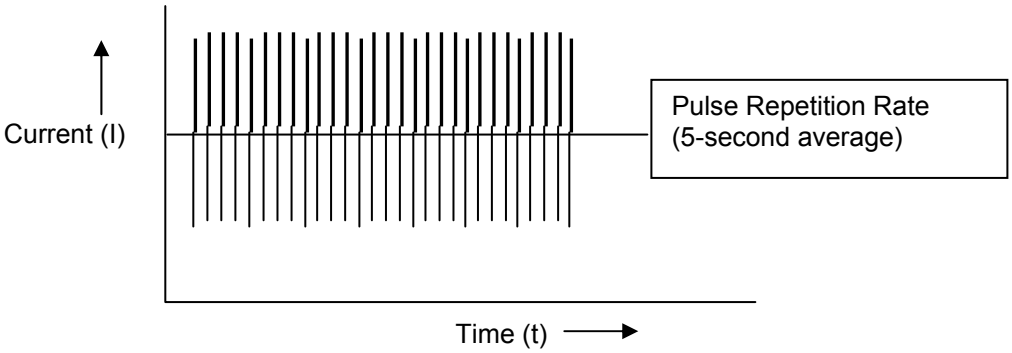


FIGURE 11: X26 PULSE REPETITION RATE

© 2009 MPB Technologies- Electronics Test Centre

6.6 PULSE ENERGY AND POWER RATING

Pulse energy and power rating delivered into the load are specified in Table 1, but are not relevant for the purpose of disrupting nerve impulses. These parameters would be relevant for a burn or heating situation, but not for the Taser. Nerve impulse disruption depends primarily on delivered current, not power or energy.

Figure 12 and Figure 13 illustrate conceptual ways that these two parameters could be measured. It is not necessary to measure these parameters in device screening tests.

The power versus time curve is the product of the voltage and current values at each instant of time.

Energy is the area under the power vs time curve, and the power rating is the total energy delivered per second. Power rating may be estimated by multiplying the energy per pulse by the pulse repetition rate.

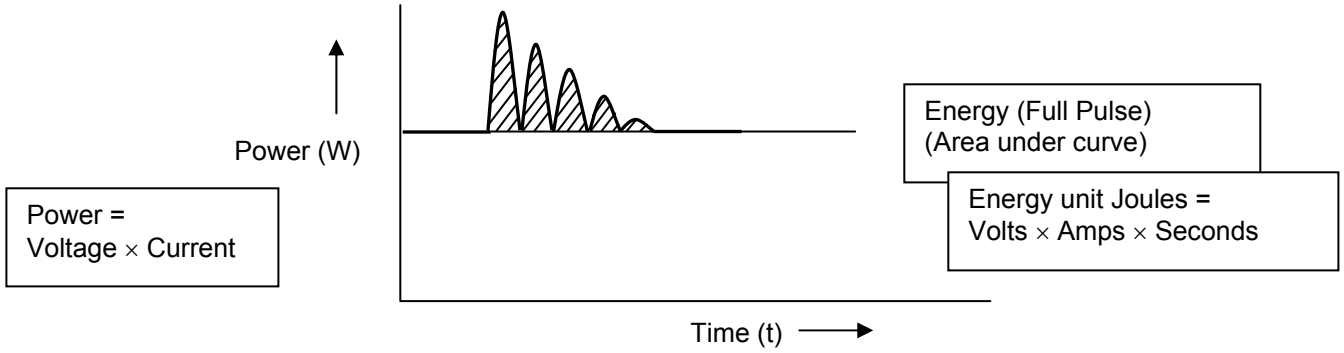


FIGURE 12: M26 PULSE ENERGY

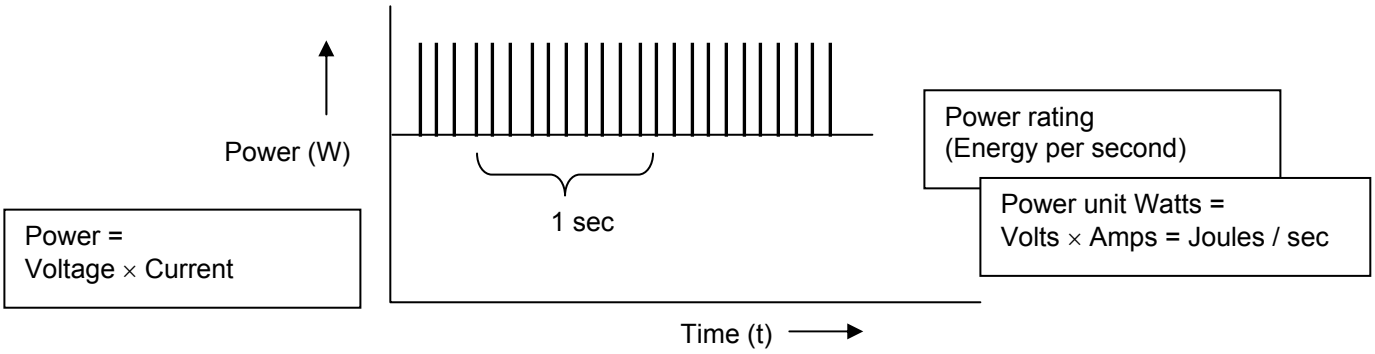


FIGURE 13: M26 POWER RATING

© 2009 MPB Technologies- Electronics Test Centre