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

Taser Model X26
Test Concepts

Prepared By:

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

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Industry Canada Industrie Canada

ISO/IEC 17025

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to establish definitions for measurement of the pulse of the Taser X26, 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 X26 models.

1.3 REVISION STATUS

Revision	Date Issued	Reason for Issue / Re-Issue
1	January 9, 2009	Draft 1
2	January 16, 2009	Draft 2
3	January 20, 2009	Draft 3
4	January 22, 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

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2 SPECIFICATIONS

2.1 OFFICIAL TASER X26 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-X26E-001_J.pdf

The following extracts from the official specifications were turned into Table 1.

Output characteristics:
Wave form: Complex shaped pulse
Pulse rate: 19 pulses per second (PPS)
Pulse duration: 100 microseconds
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: 1,200 V, avg. voltage over duration of main phase 400 V, avg. over full phase 350 V, avg. over one second 0.76 V.
Current: 2.1 mA average
Energy per pulse:
Nominal at main capacitors: 0.36 joules
Delivered into load: 0.07 joules
Power rating:
Nominal at main capacitors: 6.84 watts
Delivered into load: 1.33 watts

TABLE 1: X26 OUTPUT CHARACTERISTICS

Item	Value
Wave form:	Complex shaped pulse
Pulse rate:	19 pulses per second (PPS)
Pulse duration:	100 microseconds
Cycle length:	5 seconds
Peak open circuit arcing voltage:	50,000 V
Peak loaded voltage	1,200 V
Avg. voltage over duration of main phase	400 V
Avg. voltage over full phase	350 V
Avg. voltage over one second	0.76 V
Avg. Current	2.1 mA
Energy per pulse at main capacitors (nominal)	0.36 joules
Energy per pulse delivered into load:	0.07 joules
Power rating at main capacitors (nominal)	6.84 watts
Power rating delivered into load:	1.33 watts

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2.2 TASER X26 SPECIFICATION UPDATES

From a letter to H.D.M. Madill dated December 15, 2008 from Magne Nerheim, Vice President Research and Development, Taser International (TI). He urges testers to average values across at least eight consecutive pulses from the same device.

The particular test loads used by TI were an Ohmite Model LN100J600 600-ohm non-inductive resistor and an Ohmite model LN100J250 250-ohm non-inductive resistor

TABLE 2: X26 OUTPUT CHARACTERISTICS (FACTORY)

	600 Ω Load	250 Ω Load
Main Phase Charge	85 – 115 microcoulombs	105 – 155 microcoulombs
Pulse Duration	110 – 140 microseconds	120 – 155 microseconds
Pulse Rate (pps)	19 +0/-2 pulses per second	19 +0/-2 pulses per second
Average Current (Main phase charge * pps)	1.4 – 2.2 mA	1.8 – 3.0 mA
Main Phase Peak Current	2.4 – 3.6 A	2.3 – 4.8 A
Peak Loaded Main Phase Voltage	1450 – 2150 Volts	580 – 1200 Volts

From a note entitled “Customer Testing of Taser X26” dated January 11, 2009 from Magne Nerheim, Vice President Research and Development, Taser International. He has widened the specifications to take into account test setup variations in third party and customer laboratories.

TABLE 3: X26 OUTPUT CHARACTERISTICS (FACTORY AND CUSTOMER)

	Factory: 600 Ω Load	Customer: 600 Ω Load
Main Phase Charge	85 – 115 microcoulombs	80 – 125 microcoulombs
Pulse Duration	110 – 140 microseconds	105 – 155 microseconds
Pulse Rate (pps)	19 +0/-2 pulses per second	19 +1/-2.5 pulses per second
Average Current (Main phase charge * pps)	1.4 – 2.2 mA	1.3 – 2.5 mA
Main Phase Peak Current	2.4 – 3.6 A	2.3 – 4.2 A
Peak Loaded Main Phase Voltage	1450 – 2150 Volts	1400 – 2520 Volts

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3 TYPICAL PULSE WAVEFORM PLOTS

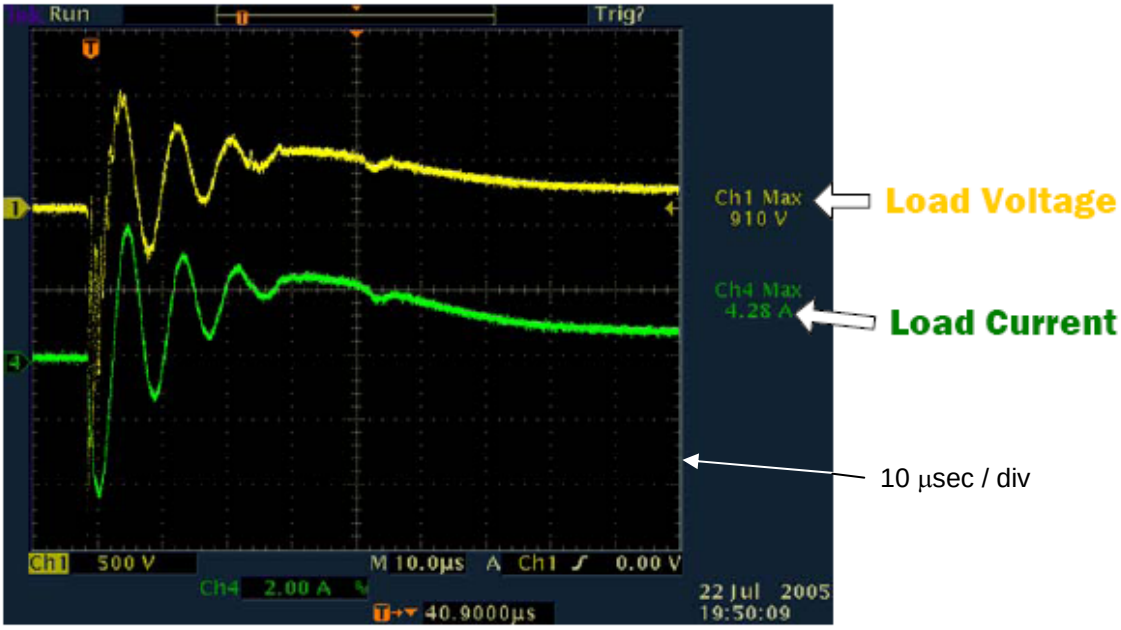

FIGURE 1: X-26 WAVEFORM (FROM TASER X26 TEST PROCEDURE)

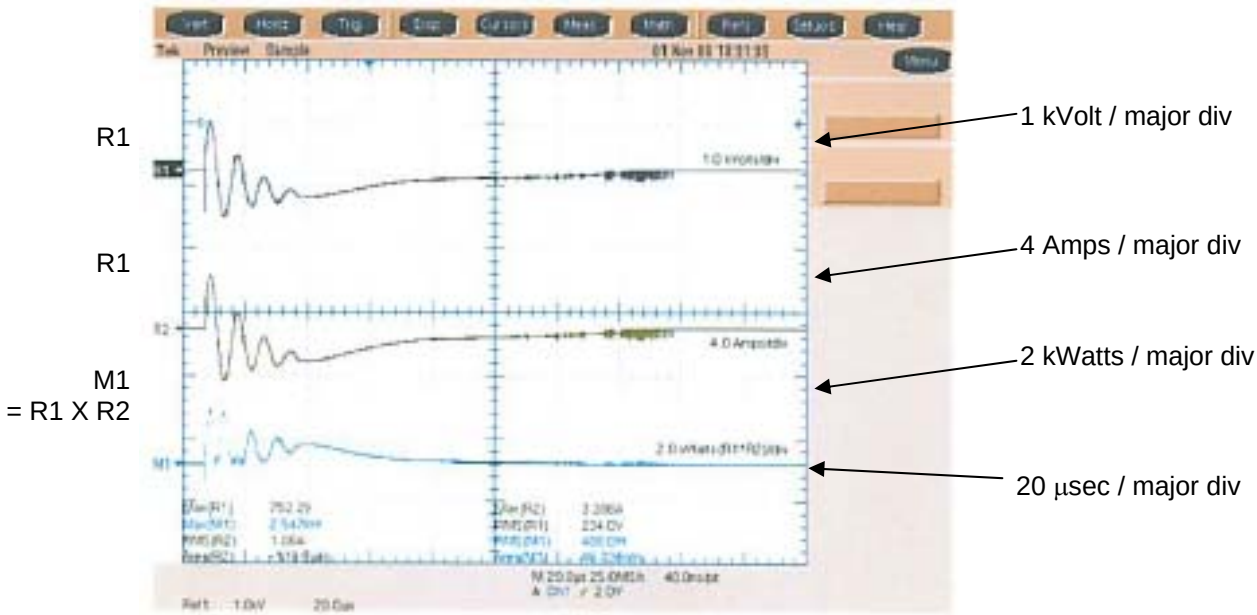

FIGURE 2: X-26 WAVEFORM (FROM NTS TEST REPORT, P. 11)[1]

[1] Testing of X26 Taser. Test Report Number 4119-08.SRC. National Technical Systems. Nov 12, 2008.

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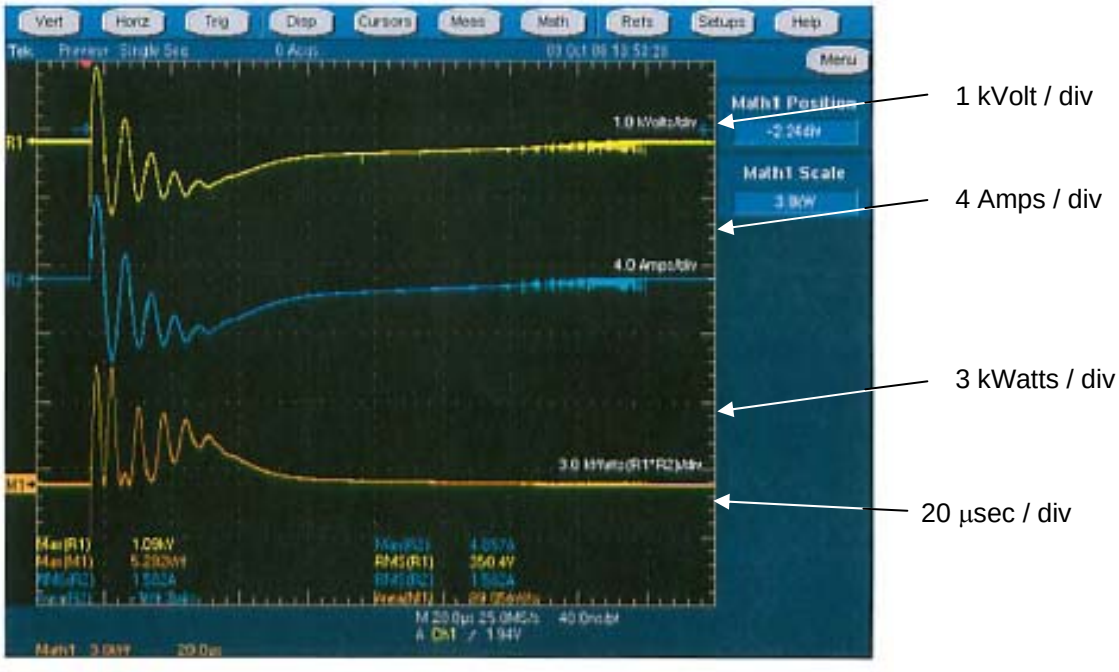

FIGURE 3: X-26 WAVEFORM (FROM SAVARD ET AL, P. 5)[2]

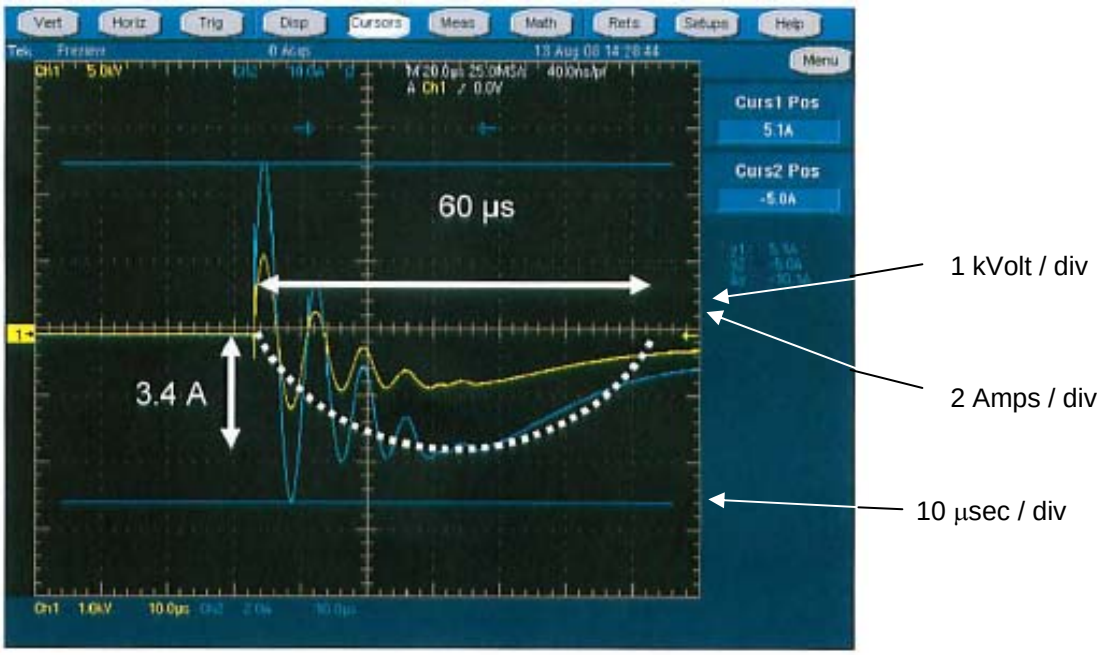

FIGURE 4: X-26 WAVEFORM (FROM SAVARD ET AL, P. 14)

[2] Savard, P., Walter, R., Dennis, A. (2008). Analysis of the quality and safety of the Taser X26 devices tested for Radio-Canada / Canadian Broadcasting Corporation by National Technical Systems, Test Report 41196-08.SRC.

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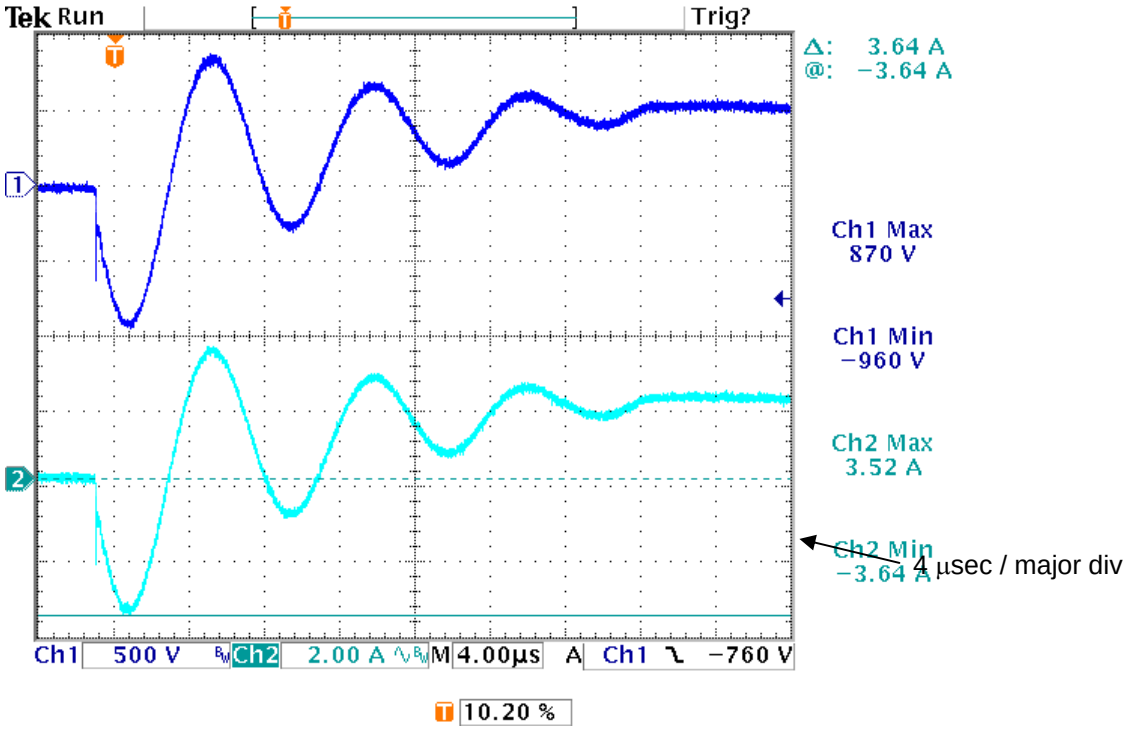

FIGURE 5: X-26 WAVEFORM (FROM ETC REPORT R1R3645, P. 30)[3]

[3] 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.

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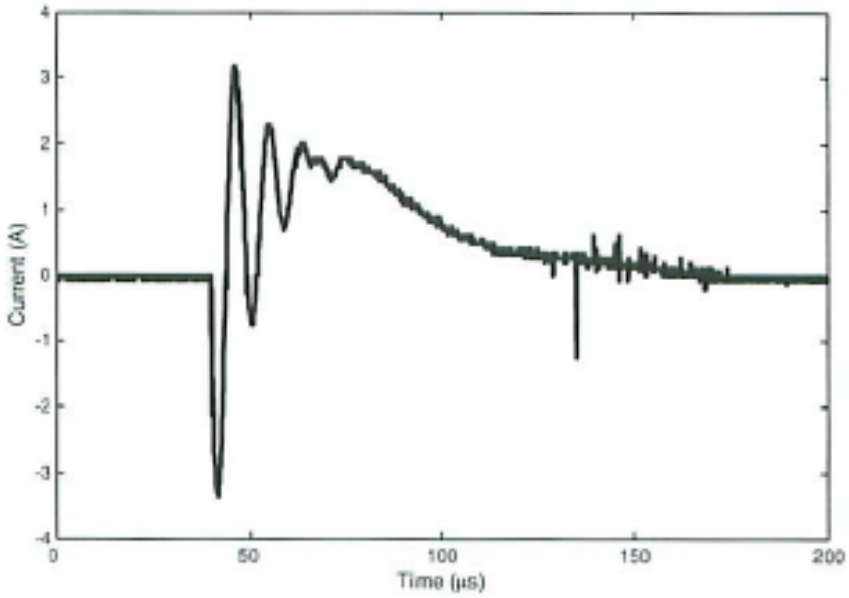

FIGURE 6: X-26 WAVEFORM (FROM NIMUNKAR AND WEBSTER, FIG 3)[4]

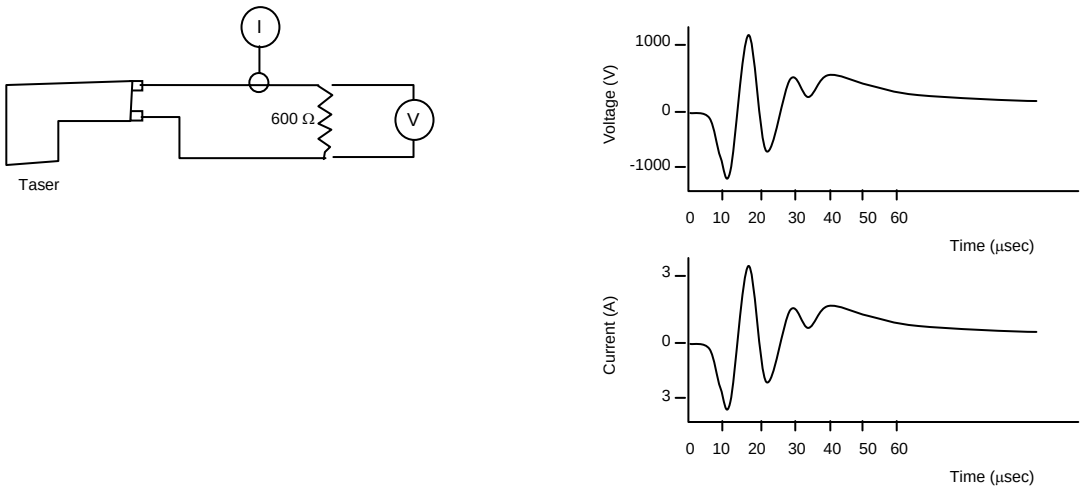

FIGURE 7: ETC TEST SETUP AND SKETCH OF TYPICAL DATA

[4] Nimunkar, A.J. and Webster, J.G. (2009) Safety of pulsed electric devices. Physiological Measurement, **30**, p. 101-114.

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4 SUGGESTED ETC TESTS

TABLE 4: X26 TEST PARAMETERS

Parameter	Condition	Spec into 600 Ω Load
Main Phase Charge	Area under main phase current vs time curve, on a pulse averaged over 8 pulses	80 – 125 microcoulombs
Voltage Pulse Duration	Between initial point of waveform where absolute voltage reaches 50 V and final point where absolute voltage drops below 50 V on a pulse averaged over 8 pulses	105 – 155 microseconds
Pulse Rate (pps)	Average over at least 14 pulses	19 +1/-2.5 pulses per second
Average Current per second	Main phase charge × pulse rate	1.3 – 2.5 mA
Main Phase Peak Current	Peak of main phase current (following arc phase), on a pulse averaged over 8 pulses	2.3 – 4.2 A
Peak Loaded Main Phase Voltage	Peak of main phase voltage (following arc phase), on a pulse averaged over 8 pulses	1400 – 2520 Volts

- Taser International Customer Specifications have been applied (from Table 3).
- Load resistor is 600 Ohm non-inductive

- 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
- 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

- Note the battery expenditure from the digital display
- If battery pack does not have a gasket, remove battery and clean the contacts
- Check for latest software update; if necessary, update by inserting a fresh battery pack with the latest revision software.

- 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 95 pulses in a cycle
- Uncertainty calculations for instrumentation setup, as per ISO 2725.

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5 WAVEFORM DEFINITIONS

The pulse consists of an “arc phase” and “main phase” as defined in Figure 8. The pulses are delivered in a “cycle” consisting of approximately 95 pulses over 5 seconds, at the rate of 19 pulses per second, as shown in Figure 9.

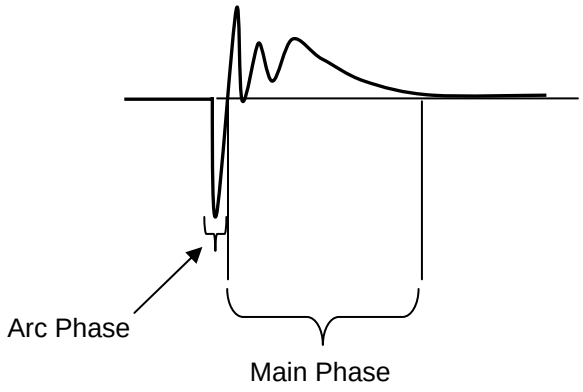

FIGURE 8: PULSE, CONSISTING OF ARC PHASE AND MAIN PHASE

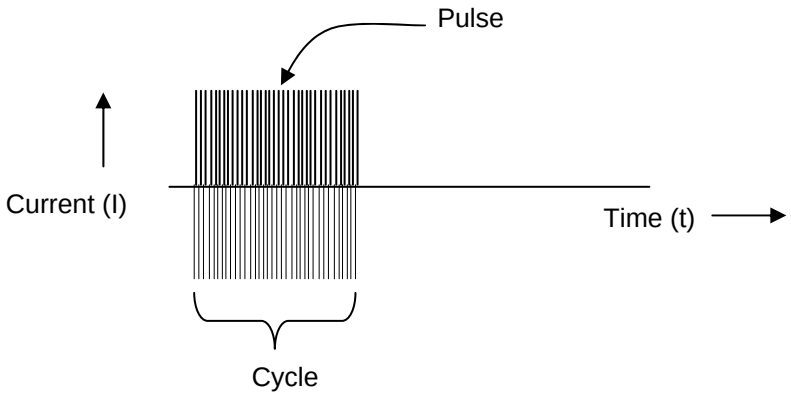

FIGURE 9: CYCLE OF APPROXIMATELY 95 PULSES

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6 MEASURED PARAMETER DEFINITIONS

6.1 INTRODUCTION

Parameters of individual X26 pulses will be calculated as shown in Figure 10 to Figure 13. These describe, respectively,

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

Explanations

Information is derived primarily from the main phase, where most of the pulse energy resides. The main phase delivers about 100 microcoulombs of charge, whereas the arc phase has only 10 microcoulombs and therefore a more limited physiological effect.

The arc phase has a faster rise time and a higher peak than seen on most oscilloscopes, because of integrating effects in the voltage and current probes. For this reason, measurements of the peak voltage, peak current and charge of the arc phase would likely be in error.

The purpose of the arc phase is to create an arc to allow efficient delivery of current during the main phase.

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

A separate discussion of power rating and energy per pulse is provided on Page 17. This is not part of the proposed test procedure.

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6.2 PEAK CURRENT AND VOLTAGE

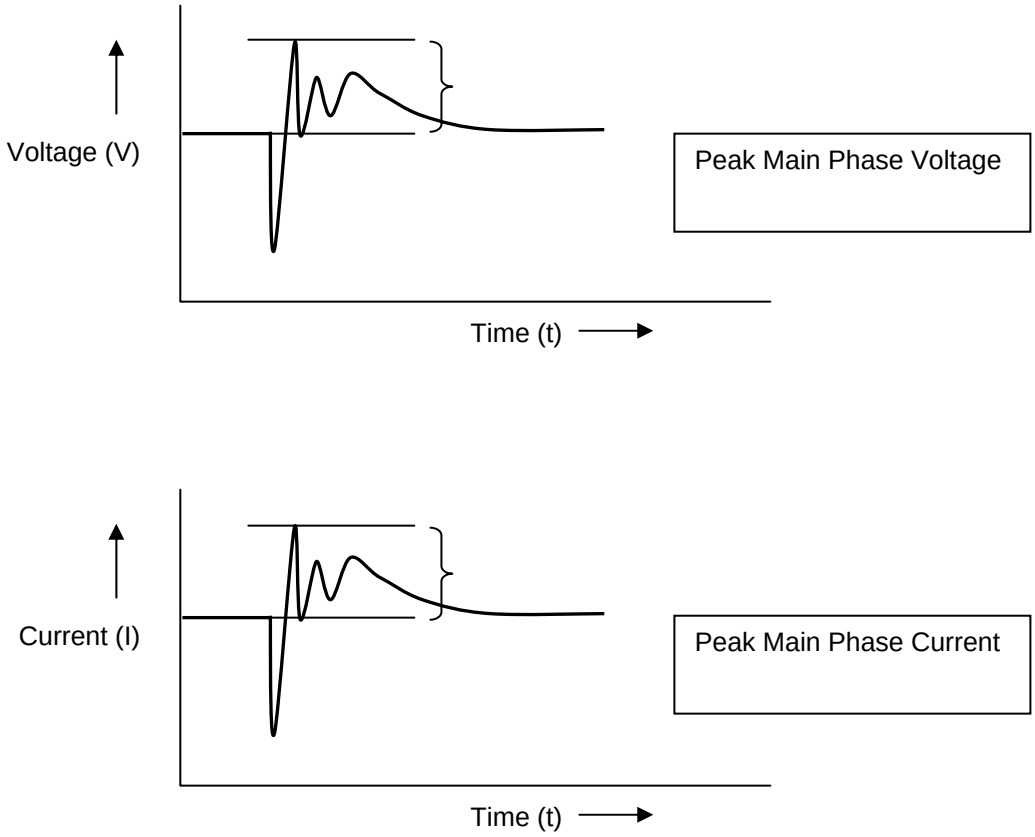

FIGURE 10: X26 PEAK MAIN PHASE CURRENT AND VOLTAGE

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6.3 PULSE CHARGE

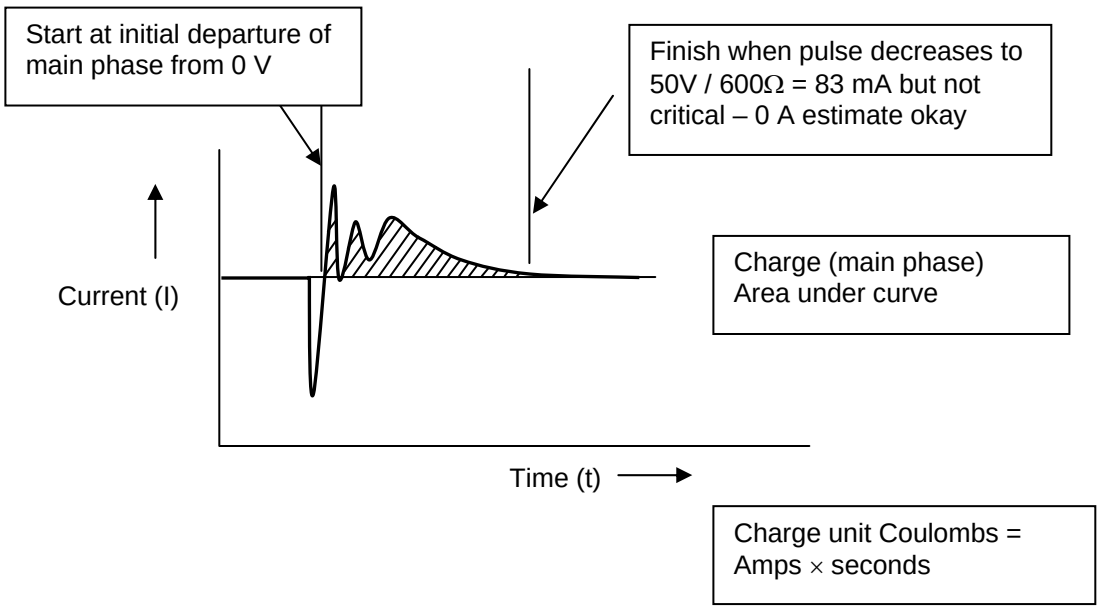

FIGURE 11: X26 MAIN PHASE CHARGE

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6.4 PULSE DURATION

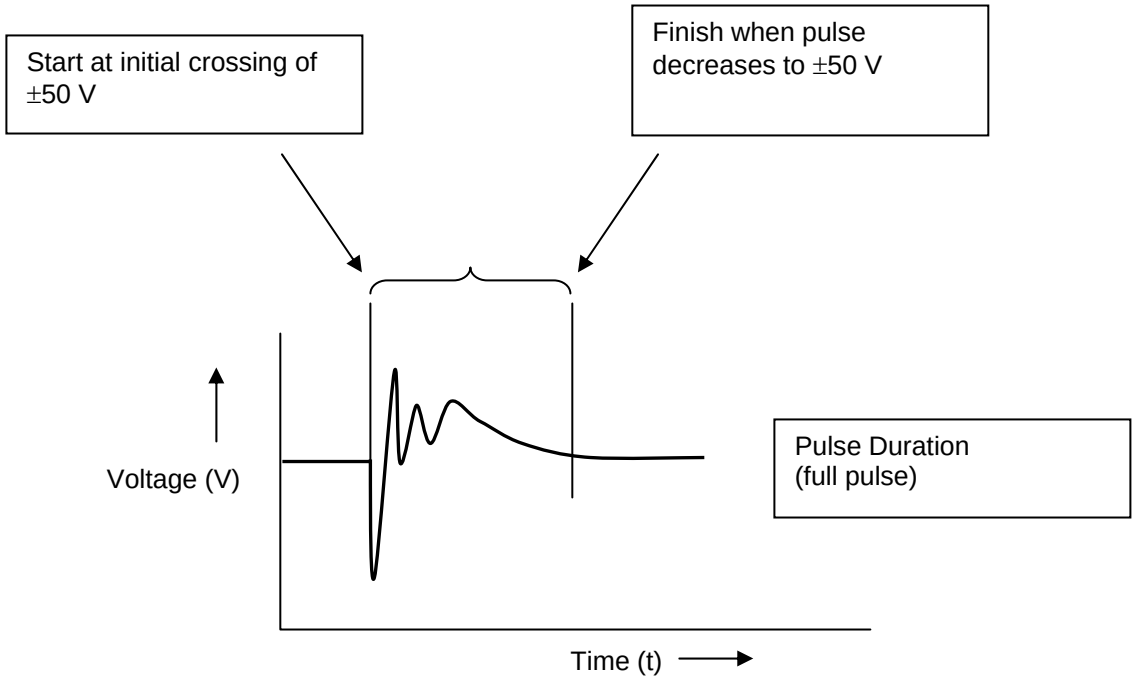

FIGURE 12: X26 PULSE DURATION

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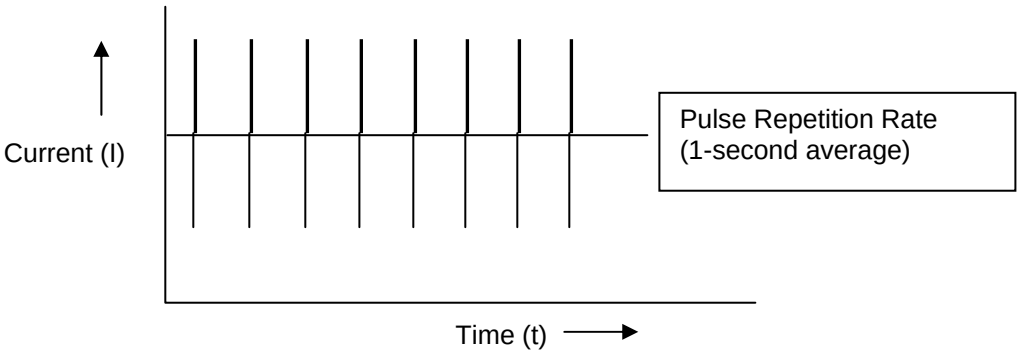
6.5 PULSE REPETITION RATE



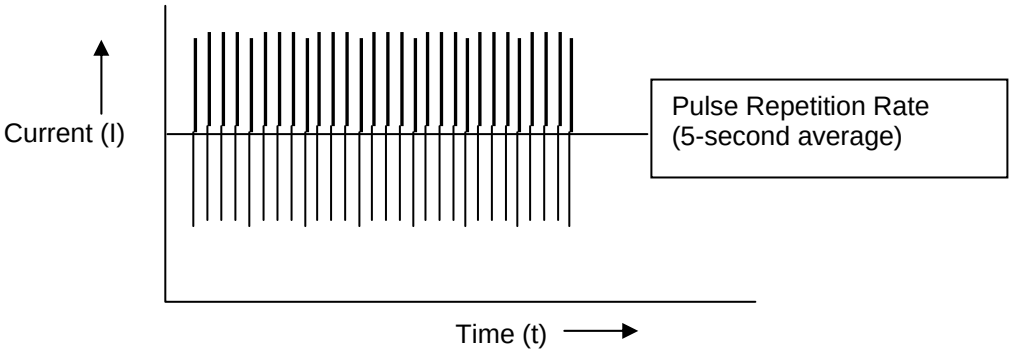


FIGURE 13: X26 PULSE REPETITION RATE

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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 14 and Figure 15 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.

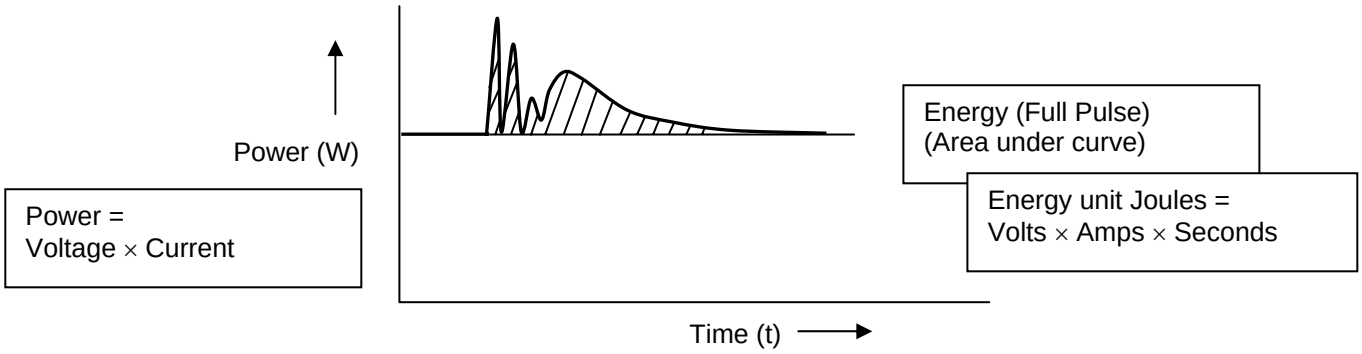

FIGURE 14: X26 PULSE ENERGY

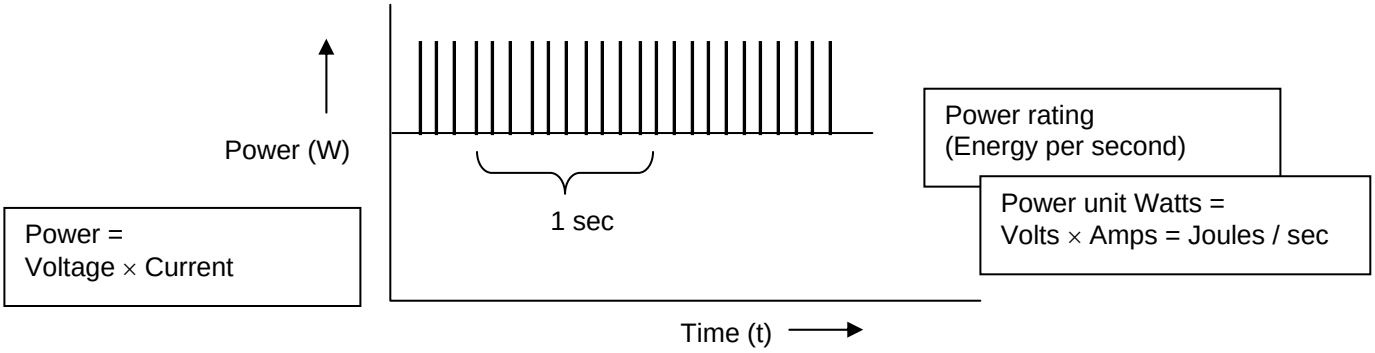

FIGURE 15: X26 POWER RATING

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