Defence Standard 59-411 issue 3
DCS05 Test Generator
User Manual

Revision History

Issue:	Modification	Date:	Modified By:
1.0	First Issue		N/A

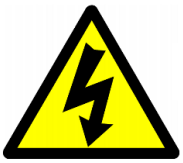
Safety Precautions

Indicates a potential electric shock hazard

Indicates a caution

This equipment delivers high voltage, high energy pulses. If misused, could cause serious injury or fatality. All safety instructions should be followed prior to and during use of this Equipment. Do not operate the Generator in a high humidity environment.

The output of this Generator delivers high voltage, high energy pulses. The output connection and test clamp should be connected prior to energising the Generator.



During the test application, no personnel should be in contact with the equipment under test or the test clamp. Personnel should maintain a 0.5 metre separation distance between the clamp and equipment under test during pulse application.

This equipment should only be operated by trained personnel that understand the safety implications of Generator misuse. Under no circumstances should the Generator be left energised and unattended.

The rear earth terminal should be connected before use. This should be a separate earth connection to the mains i.e. bonded to a ground plane or to a screened room connection point.

Connections from the test Generator to the clamp should be in “HN” Type co-axial cable. If the clamp supports only 4mm plug connections these should be shrouded. Under no circumstances should the Generator be operated without a clamp connected.

The Generator is designed for use with the supplied clamp. If a different clamp is used, the Generator output will not be correct and in certain circumstances the Generator could be damaged.

The applied pulse is a high energy pulse and in certain conditions could cause equipment under test components to explode. It is recommended that eye protection is worn during this test to prevent injury.

Use of this Generator in a manner not specified within this manual could cause damage to the Generator, the Equipment Under Test or cause operator injury.

There are no serviceable parts inside the Generator, do not attempt to disassemble or repair the Generator. In the event of a failure or damage to the Generator please contact the manufacturer for servicing.

Do not operated the Generator if any visible external damage is noted. The Generator should be returned to the manufacturer for repair. To clean the Generator, a clean damp cloth should be used with no detergent.

The supplied calibration jig and the rear of the test Generator should be connected to a separate protective earth connection prior to use. The supplied calibration jig is only for use on a ground plane.

This Generator weighs 25 kg, care should be taken when handling and moving the Generator.

Contents

Contact Details

In the event of an equipment failure, repair or any other general enquiry please use the following contact details, quoting the Generator type and serial number:

The Conformity Assessment Business

4 Dorcan Business Village Murdock Road, Dorcan, Swindon, England, SN3 5HY

info@conformity-assessment.com

+ 44 (0) 1704 821376

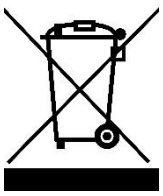
+ 44 (0) 7943 405145

North American Support:

ABSOLUTE *EMC* Llc. Covering sales in North America United States, Mexico, & Canada

absolute-emc.com
Phone:703-774-7505
info@absolute-emc.com

Waste Electrical Equipment (WEE)



The Conformity Assessment Business undertake to accept this Generator at it's end of life for recycling. Please contact us direct to arrange pickup at our cost should the Generator be no longer needed or serviceable.

EU Declaration of Conformity

THE CONFORMITY ASSESSMENT BUSINESS
COMPLIANCE DELIVERED

Declaration of Conformity

For

DCS05 Generator

Applicable Directives:

- **Low Voltage Directive: 2014/35/EU**
- **EMC Directive: 2014/30/EU**
- **RHoS Directive: 2011/65/EU**
- **WEE Directive: 2012/19/EU**

Standards used to demonstrate compliance:

EN 61326-1: 2013 Electrical equipment for measurement, control and laboratory use — EMC requirements Part 1: General requirements

EN 61010-1: 2010 Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements.

EN 61010-2-010: 2014 Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-2010: Particular requirements for laboratory equipment for the heating of materials.

We:

The Conformity Assessment Business Ltd.

Registered office address:

609 Delta Business Park, Welton Road, Swindon, United Kingdom, SN5 7XF

Declare that the DCS05 Generator meets all applicable Directives, This declaration of conformity is issued under the sole responsibility of the manufacturer:

Signed: 

Date: 17 November 2021

Peter Green, Director (The Conformity Assessment Business)

UK Declaration of Conformity

THE CONFORMITY ASSESSMENT BUSINESS
COMPLIANCE DELIVERED

Declaration of Conformity

For

DCS05 Generator

Applicable UK Legislation:

- **Electrical Equipment (Safety) Regulations 2016**
- **Electromagnetic Compatibility Regulations 2016**
- **The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012**

Standards used to demonstrate compliance:

BS EN 61326-1: 2013 Electrical equipment for measurement, control and laboratory use — EMC requirements Part 1: General requirements

BS EN 61010-1: 2010 + A1:2019 Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements.

EN 61010-2-010: 2014 Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-2010: Particular requirements for laboratory equipment for the heating of materials.

We:

The Conformity Assessment Business Ltd.

Registered office address:

4 Dorcan Business Village Murdock Road, Dorcan, Swindon, England, SN3 5HY

Declare that the DCS05 Generator meets all applicable UK Legislation, This declaration of conformity is issued under the sole responsibility of the manufacturer:

Signed: 

Date: 17 November 2021

Peter Green, Director (The Conformity Assessment Business)

Introduction

When coupled to its matched test clamp, the Generator produces damped oscillatory wave transients in the frequency range 500kHz to 50 MHz that meet the definition of a type 1N Generator verification requirements Defence Standard 59-411.

9 Fixed frequencies are available: 500 kHz, 1 MHz, 2 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz 35 MHz and 50 MHz.

This Generator is designed and for use only in testing to test DCS05 of Defence Standard 59-41, for application of both Switching and NEMP test levels. For switching levels up to 15 MHz, a suitable attenuator is provided for use with the Generator. This is required in order to maintain a suitable charge level which enables the Generator to meet the damping and frequency requirements at the lower test levels.

Hardware Overview

Main Power Switch

The main power switch is located on the rear of the Generator above the IEC mains power inlet.

Output Ports

The Generator has two pulse output ports that are located on the front panel these cover pulses in the frequency range 500 kHz to 3 MHz and 5 MHz to 50 MHz. The ports use non-standard ‘HN’ type connectors (High Voltage ‘N’ type) and should only be connected to the supplied clamp and cable.

High Voltage Enable Switch

The high voltage enable switch is located on the front panel. This is a latching push button LED illuminated switch that is recessed (not protruding) to prevent inadvertent operation. This switch works independently of the high voltage interlock on the rear of the Generator and both must be enabled before the high voltage circuit is energised.

Only enable the High Voltage front panel switch when the Generator is in active use. In between test programmes and during any down time it is recommended that the switch is in the off position (not illuminated)

High Voltage interlock

A separate high voltage interlock is located at the rear of the Generator. This is normally closed (enabled) by the use of a shorting link. For external control, the jumper can be replaced with any suitable relay switch or, alternatively, taking the red terminal “low” to chassis ground potential.

The high voltage interlock works in conjunction with the front panel High Voltage Enable switch. Both must be enabled before the high voltage circuit is energised.

The interlock terminals are not at a hazardous voltage and are a low voltage high impedance input.

Touch Screen Display

All the user input and control is via the front 10” touch screen display. The pulse application is also triggered via the display and there are no separate hardware buttons that perform this function. Full control information is covered under the software operating section of this manual.

Rear “Earth” terminal

This is a secondary safety earth and should be connected at all times when the Generator is in use.

DCS05 Test Requirements

Test overview

The DCS05 Generator applies Defence Standard 59-411 damped oscillatory transients to Equipment Under Test (EUT) using a matched clamp. The cable under test is passed through the clamp and the transients applied at a pre-calibrated current level (current into 10Ω).

The Generator software stores the voltage set at the calibration phase of the test for each of the nine pulses. During the test application the software sets the required charge voltage for each of the pulses as they are selected. This allows a full 9 pulse calibration to be carried out and saves time during the test phase. Pulses can be applied as a singular pulse or in a repetition of 1-100 pulses, with a 2 – 60 second interval.

For switching pulses it is important to keep the charge voltage high to maintain the correct waveshape and damping characteristics. A suitable pulse attenuator to achieve this is supplied with the Generator, this should be connected at the injection clamp when performing Switching Level transients and is used in the frequency range 500 kHz to 15 MHz.

Generator Calibration and Verification

Defence Standard 59-411 DCS05 requires that several key parameters are met when the clamp is terminated in the 10 Ω test jig. These are:

- The output frequency – This is averaged over the first 8 half cycles of the pulse
- Damping – The amplitude of the 8th half cycle should be between 75 % and 25 % of the peak half cycle
- The output amplitude – This is taken as the peak half cycle (this may not be the first)

Measurement Equipment Requirements

The following oscilloscope probes should be used:

500 kHz to 15 MHz – 100:1 probe with a minimum 1.5kV peak voltage capability, 100 MHz minimum bandwidth.

35 MHz and 50 MHz – 10:1 probe with a minimum 300V peak voltage capability, 200 MHz minimum bandwidth.

When measuring high voltage waveforms, under or over compensated oscilloscope probes can have a significant effect on the measured voltage amplitude. It is therefore important to ensure that prior to any measurements that probe compensation is carried out.

To carry out probe compensation, the oscilloscope probe should be connected to the compensation square wave output on the oscilloscope and the probe compensation terminal adjusted until a perfect square wave is seen on the oscilloscope. The compensation terminal location is typically adjacent to the probe connector.

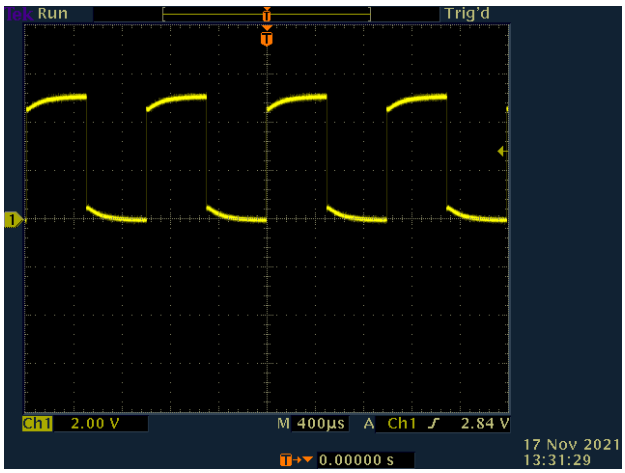


Figure 1 - Over Compensated Probe

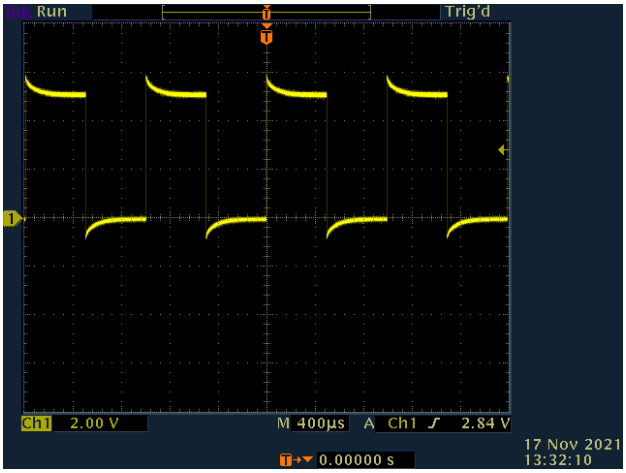


Figure 2 - Under Compensated Probe

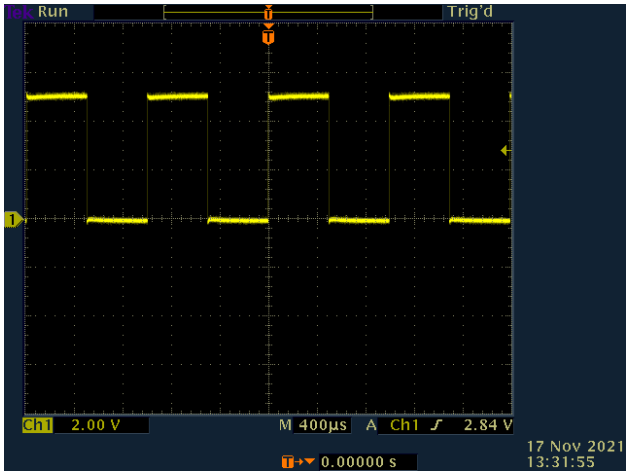


Figure 3 - Correct Probe Compensation

An oscilloscope with a minimum 200MHz bandwidth should be used for verification of the DCS05 waveform.

Calibration setup

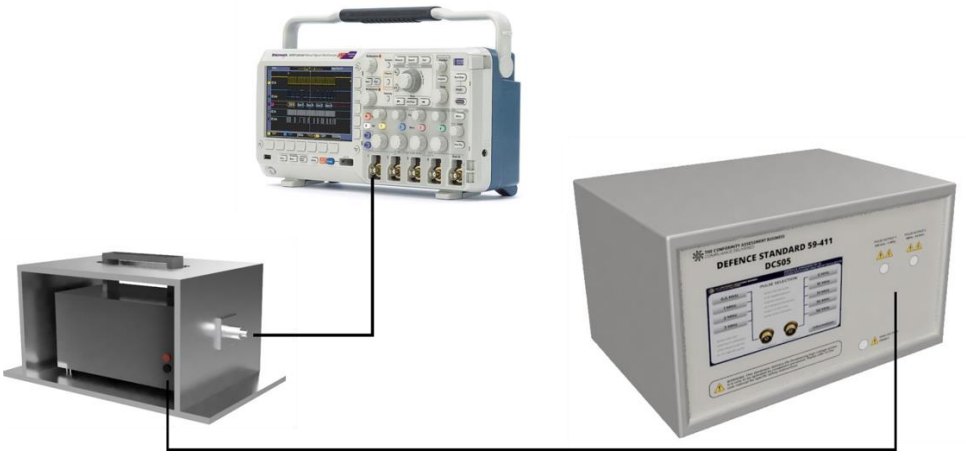


Figure 4 - Calibration Setup

Figure 4 shows the calibration setup. The Generator is connected to the clamp using the supplied cable and the clamp located in the 10 Ω test jig.

⚠ The 10 Ω test jig should be bonded to a ground plane.

The oscilloscope probe should be connected directly to the 10 Ω test jig 'N' type output port. This connection should be made with a co-axial probe adaptor shown in figure 5.

Figure 5 - Co-axial probe connection

Measurement of output frequency

The output frequency is taken as the average of the first eight half cycles of the waveshape when measured in the 10 Ω test jig. This should be within ±10 % of the set frequency. The following formula is used to calculate frequency.

$$Frequency\ (Hz) = \frac{1}{T \div 4}$$

Where: T = The total time for 8 half cycles in s

The following example shows the frequency measurement for a 500 kHz damped oscillatory wave:

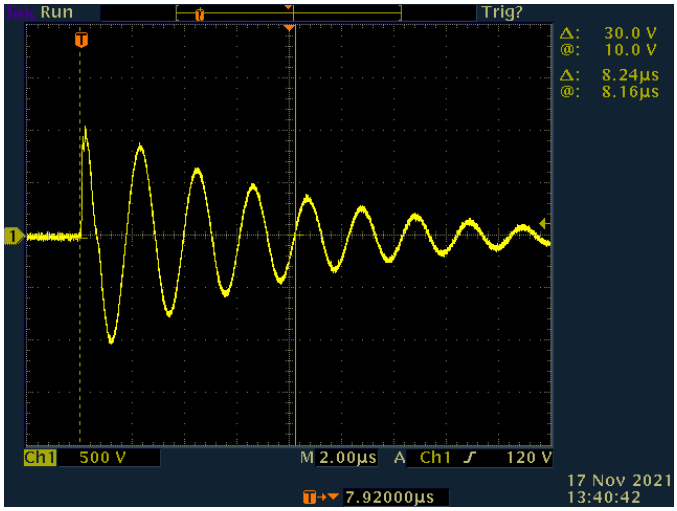


Figure 6 - Frequency Measurement Example (500 kHz)

In this example: Time for eight half cycles = 8.24 µs, therefore:

$$Frequency\ (Hz) = \frac{1}{8.24\ \mu s\ \div 4} = 485.4\ kHz$$

The allowed tolerance for this frequency is 450 kHz to 550 kHz, therefore the wave meets the frequency verification requirements of the standard.

Measurement of output level

The output level is classed as the amplitude of the peak half cycle, this may not be the first half cycle.

Limits are in terms of current flow in the 10 Ω load of the test jig. Ohms law is used to calculate the load current based on the voltage developed across it.

$$Current\ (A) = \frac{Peak\ Voltage\ Measured\ (V)}{10\ (\Omega)}$$

As per section 6.1 of Defence Standard 59-411, the tolerance on level setting is ± 5 %.

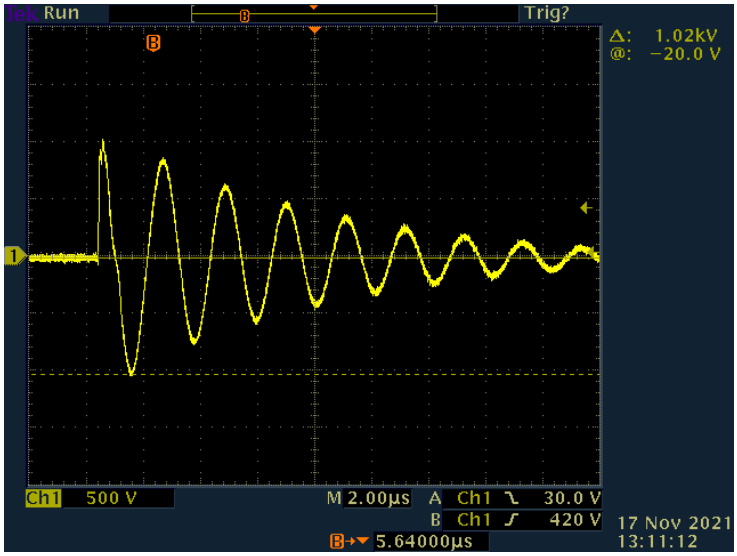


Figure 7 - Output Level Setting into 10 Ω

In this example:

$$Current\ (A) = \frac{1020\ V}{10\ (\Omega)} = 102A$$

The allowed tolerance is 95A to 105A, therefore the measured wave meets the level setting requirements of the standard.

The following Defence Standard 59-411 DCS05 test levels apply:

Frequency (MHz)	Output Level (Apk) into 10 Ω				
	Switching Simulation	NEMP Simulation			
		Sea Services		Land Services	
	All Land and Sea Services	Below Decks	Above Decks	Equipment Mounted in an Armoured Vehicle	Equipment in an Unprotected Location
0.5	10	25	100	10	20
1	10	25	100	14	28
2	10	25	100	20	40
3	10	25	100	20	40
5	10	25	100	20	40
10	10	25	100	20	40
15	7	16.75	67	20	40
35	3.4	7.25	29	20	40
50	2.5	5	20	20	40

Damping Performance

The damping performance is defined as the highest peak half cycle amplitude compared with the peak of the 8th half cycle. The 8th Half cycle should lie between 25 % and 75 % of the highest peak half cycle.

Note: The wave shape can look significantly different across this spread of damping tolerance. The following idealised waveforms show damped waves at either end of this damping tolerance:

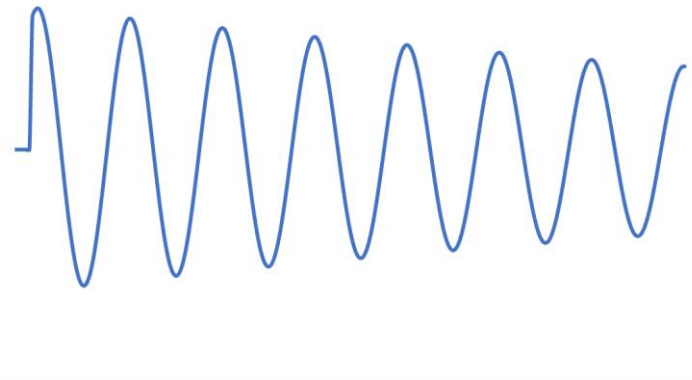


Figure 8 - Damped Oscillatory Wave - 8th half cycle at 75%

Figure 9 - Damped Oscillatory Wave 8th half cycle at 25 %

The following example shows the measurement of damping performance for a 500 kHz DCS05 wave.

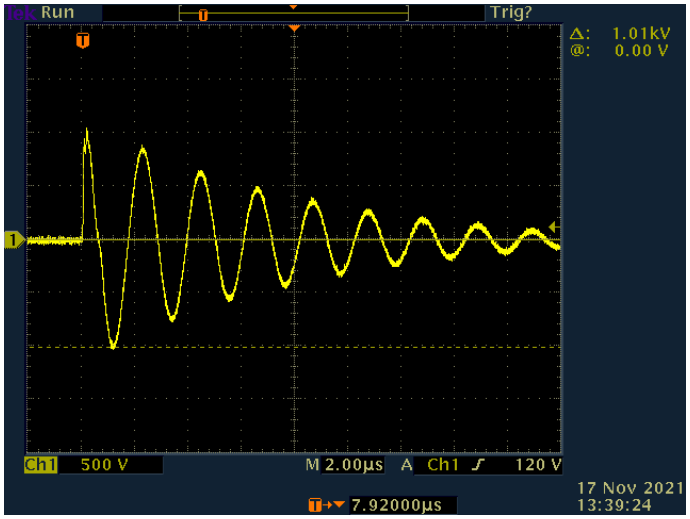


Figure 10 - Measurement of peak level for damping performance

In this example the peak half cycle measures 1010V and therefor the 8th half cycle should measure between 252.5 V and 757.5 V.

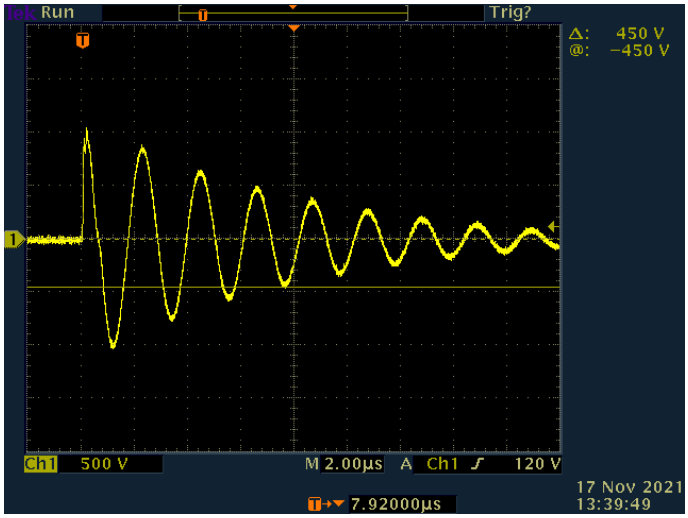


Figure 11 - Measurement of the 8th half cycle for damping performance

The 8th Half cycle measures 450 V and therefore the damping performance requirements are met.

Generator Operation

The Generator is controlled by a touch screen display located on the front panel. All operations including manual pulse triggering are carried out by the touch screen interface.

Initial Switch On

During initial switch on, the Generator needs to align the pulse discharge cartridge. Depending on the position this was last at on switch off, cartridge alignment can take up to 15 seconds.

Initial Start-up Warning

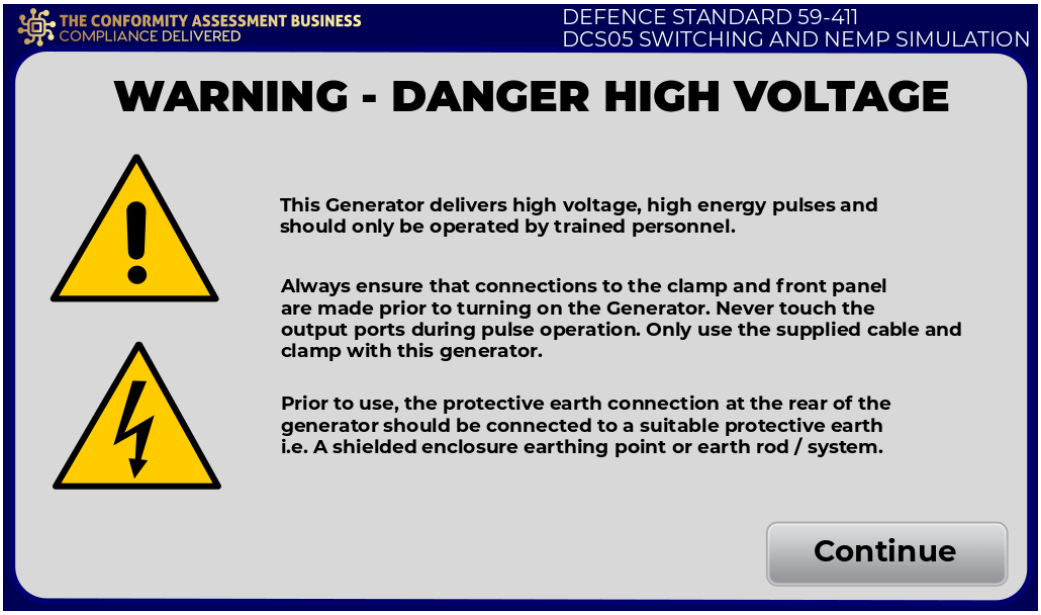


Figure 12 - Software based warning screen

For safety, it is essential that the Generator is connected to a secondary earth, this is usually the screened room earth point.

Do not connect the test lead and clamp unless the high voltage enable switch is off (not illuminated)

Pulse Selection

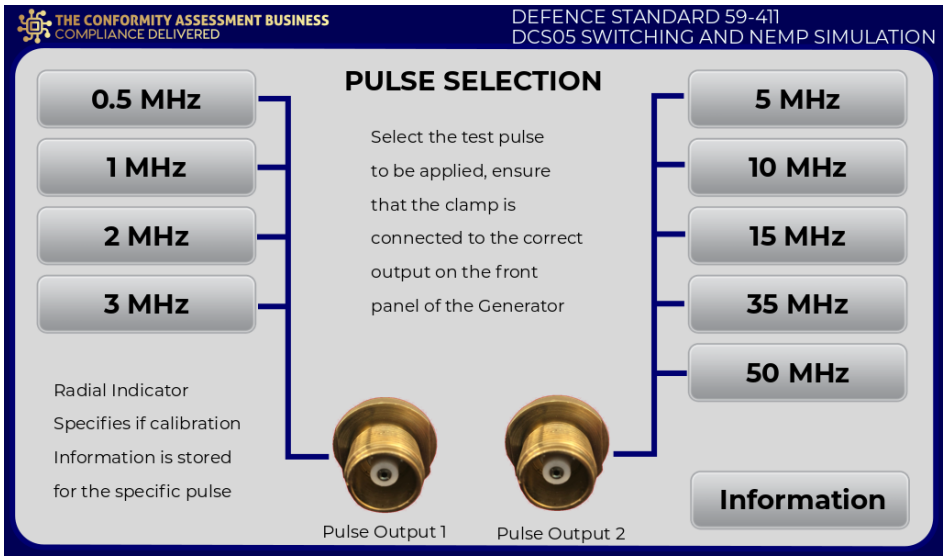


Figure 13 - Main pulse selection screen

Select the required pulse from the menu. Each pulse button has a radial indicator embedded (not shown), if the radial indicator is set (black) this indicates that a calibration drive level has been stored for that particular pulse.

Calibration / Test Screen

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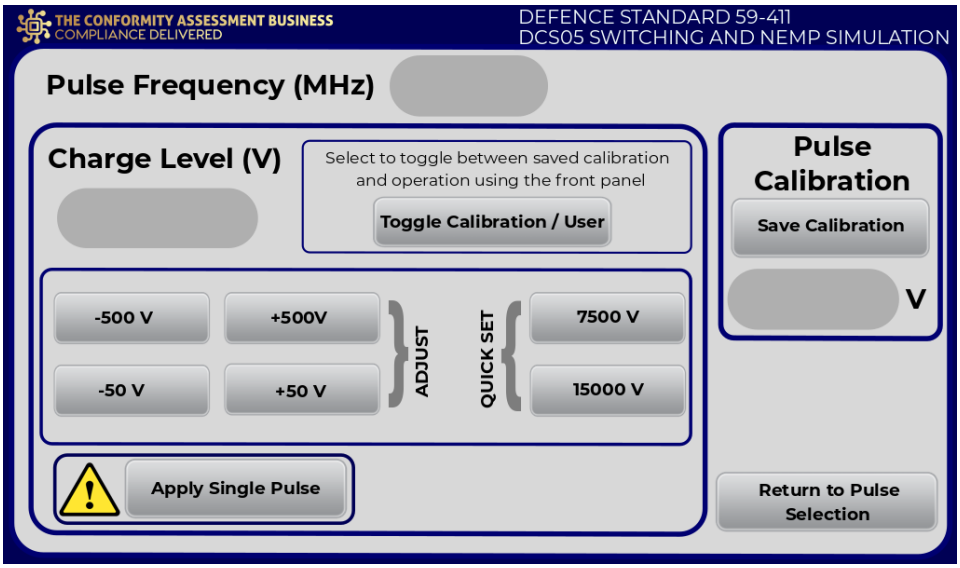

Figure 14 - Calibration screen

Operating Procedure:

[1] Ensure that the Generator is connected to the test clamp and the secondary PE connection is made at the rear of the test Generator. The clamp should be located in the 10 Ω calibration jig for this part of the calibration, the test jig should be bonded to the ground plane.

[2] Connect an oscilloscope to the 10 Ω test jig output port. A suitable co-axial probe adaptor should be used for this measurement. Note the probe requirements: a 100:1 probe should be used in the frequency range 500 kHz to 15 MHz and a 10:1 probe at 35 MHz and 50 MHz. This ensures that the oscilloscope vertical gain is not too sensitive and reduces noise on the measured waveform.

[3] Ensure that the High Voltage Interlock on the rear of the Generator is connected and that the High Voltage Enable button is on (illuminated).

[4] During the application of transients it is essential that personnel do not touch any part of the test setup except the test Generator and oscilloscope.

[5] The voltage increase and decrease buttons can now be adjusted until the oscilloscope shows the required test level peak voltage. A single discharge is triggered by pressing the “Apply Single Pulse” button.

[6] When the correct test level voltage is measured on the oscilloscope, the waveshape (damping and frequency) parameters can be verified. Press the “Save Calibration” button and return to the pulse selection screen.

[7] The calibration process should be carried out for all applicable frequencies.

Test Application

When the level setting and pulse verification is complete. Select the required pulse and press toggle calibration / User. This then sets the correct charge voltage from the calibration phase for that particular pulse.

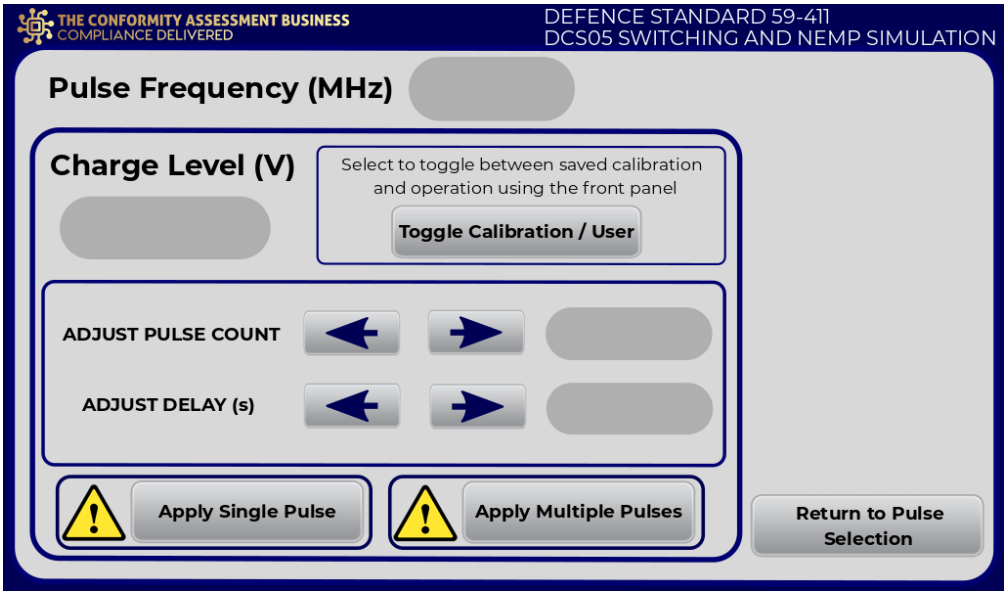

Figure 15 - Pulse application screen

Operating Procedure:

[1] Set the test Generator and equipment under test up as per the requirements of Defence Standard 59-411DCS05 – Diagram Below:

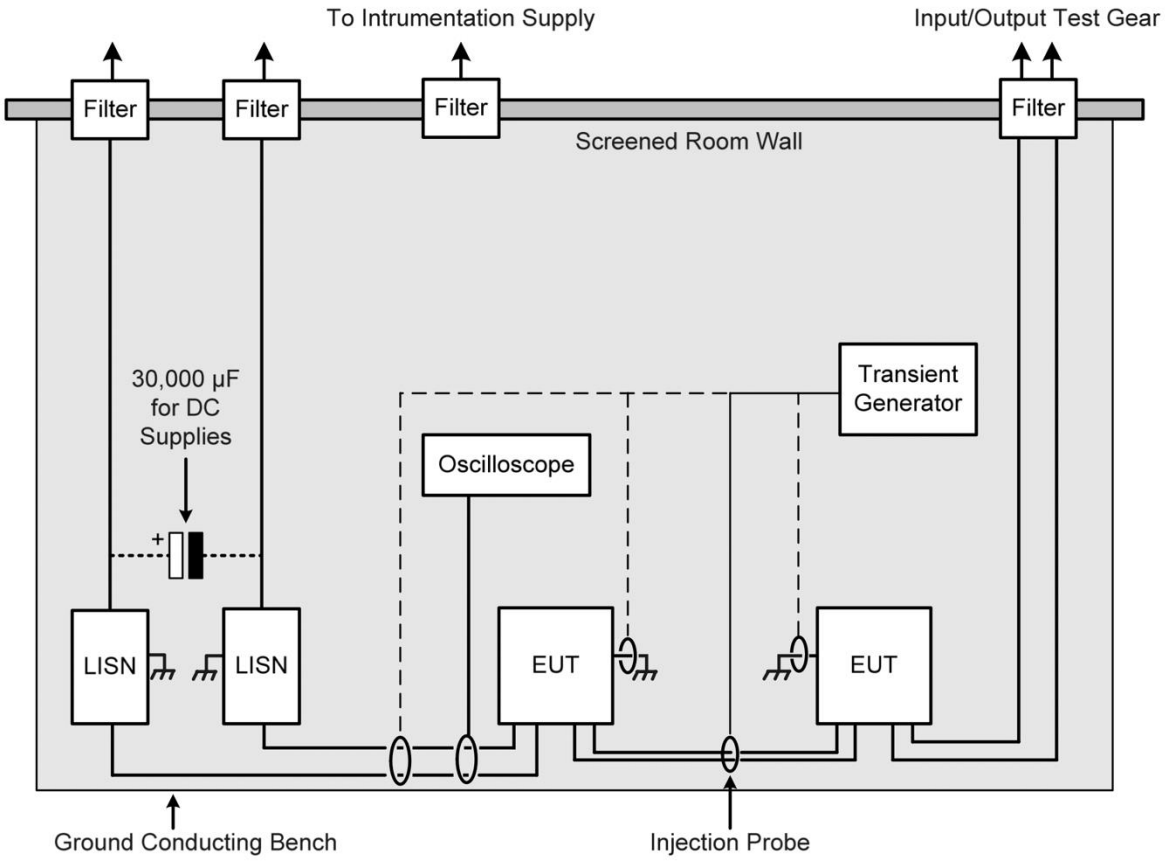

Figure 16 - General DCS05 test setup

[2] Ensure that the High Voltage Interlock on the rear of the Generator is connected and that the High Voltage Enable button is on (illuminated).

[3] Pulse calibration should be carried out for each of the applied pulses as per the previous section.

[3] Pulses can be applied using either the 'apply single pulse' button or the 'apply multiple pulses' button. The pulse interval and number of repetitions can be set from this page. 0-100 pulses and 2 – 60 seconds can be set under the multiple pulse option.

Note: Defence Standard 49-411 DCS05 requires a minimum of 2 seconds between pulses.

Electrical and Mechanical Specifications

Supply Voltage and Frequency: 110 - 230 V 50-60 Hz supply

Maximum current draw = 2A

IP Rating: IP3X

For indoor use only

Overvoltage category II