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**NoiseKen**<sup>®</sup>  
Total Coordinator for EMC



**INS4020/4040**

# **Impulse Noise Simulator**



**INS-AX2**

**Noise Laboratory Co.,Ltd.**  
**www.noiseken.co.jp**

# Compliance to a standard or to the real world?

*No one could have doubt as to the importance of the pulsed EMI test.*

*In fact, in the scheme of international compliance, the Electrical Fast Transient/ Burst test is a must for almost all products.*

*As logic circuits get faster, they tend to be more susceptible to higher frequency disturbances.*

*Does your test program represent this scenario?*

Noise-related malfunctions of electronic equipment containing electronic control devices, such as information technology equipment, are now becoming a serious problem in today's society.

One of the best-known sources of interference is the inductive component through which a current is interrupted. It is represented by the switching on and off of a relay. This type of noise has a broadband interference spectrum; thus it is coupled to wires and printed circuits in equipment, reflecting and resonating and being amplified by an IC to cause equipment malfunction.

## A market proven conducted immunity test method

The Impulse Noise Simulator (abbreviated to INS) design comes from test equipment invented by an American computer manufacturer in early 1970's when events of malfunctions of digital equipment had just begun to emerge in society. Now the INS method is the established test method in Japan and other Asian countries. In fact, the number of INS units shipped exceeds 5,000.

## The first priority is to reproduce the upset of digital equipment

If you are facing an immunity problem, the first priority should not be just testing, but rather built-in solutions in your equipment. The simulator you are about to use must reproduce the identical phenomena happening in the field.

## Complementary to the IEC61000-4-4 EFT/Burst test

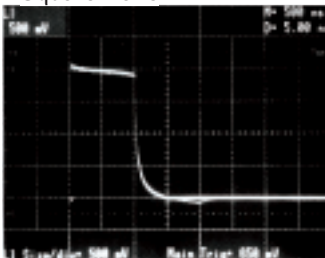
The NoiseKen INS-series Impulse Noise Simulators with unique valuable features and capabilities, most of which are not met by Electrical Fast Transient/Burst generators, greatly helps to enhance your test program to ensure your products are really immune from real world phenomena.

## ■ FEATURES

- 1ns rise time square pulse containing a frequency component of up to 2 GHz regions
- Variable pulse widths from 50ns to 1 $\mu$ s in 50ns steps for compensation for the lack of a specific interference frequency band
- Line to line and line to ground coupling modes
- Synchronous and asynchronous pulse placement with AC phase angle
- Dedicated capacitive and inductive coupling clamps are optionally available
- A market proven test method with a 30-year history

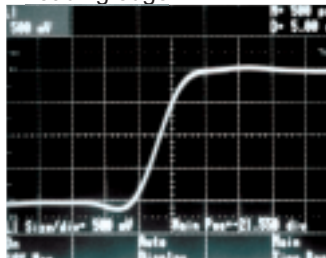
## ■ WAVEFORMS

- Square wave



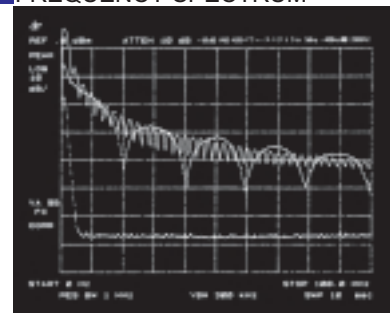
V:500V/Div H:500ns/Div  
50 $\Omega$  termination

- Leading edge



V:500V/Div H:0.5ns/Div

## ■ FREQUENCY SPECTRUM



+60dB INS series pulse power spectrum,  
50ns and 400ns width (2000V)

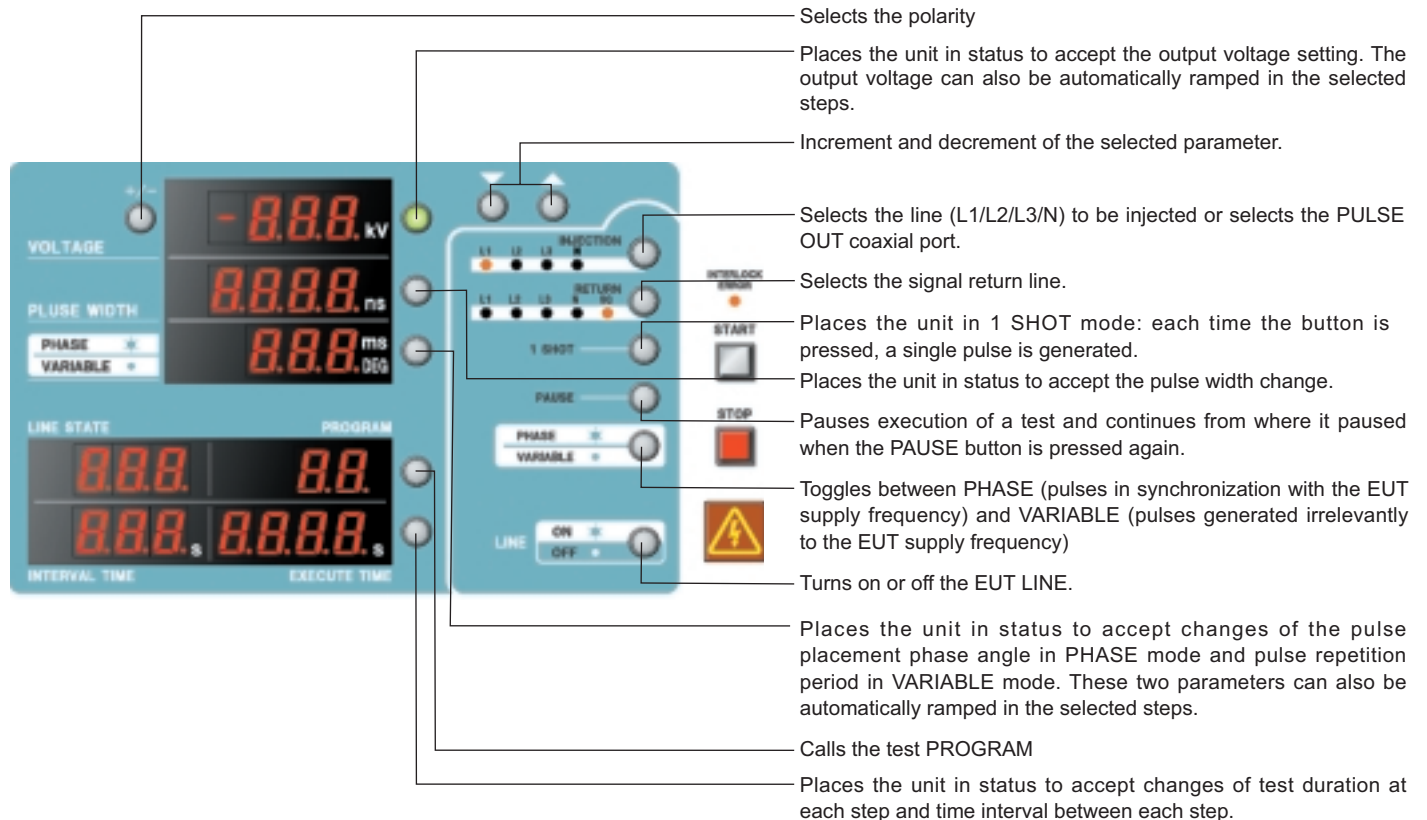
# INS-AX2 series 220/420/250/450

INS-AX2 series simulators are the advanced version of the conventional manually operated INS-4020/4040 simulators, maintaining the identical interference signal characteristics while offering a new level of ease of use.

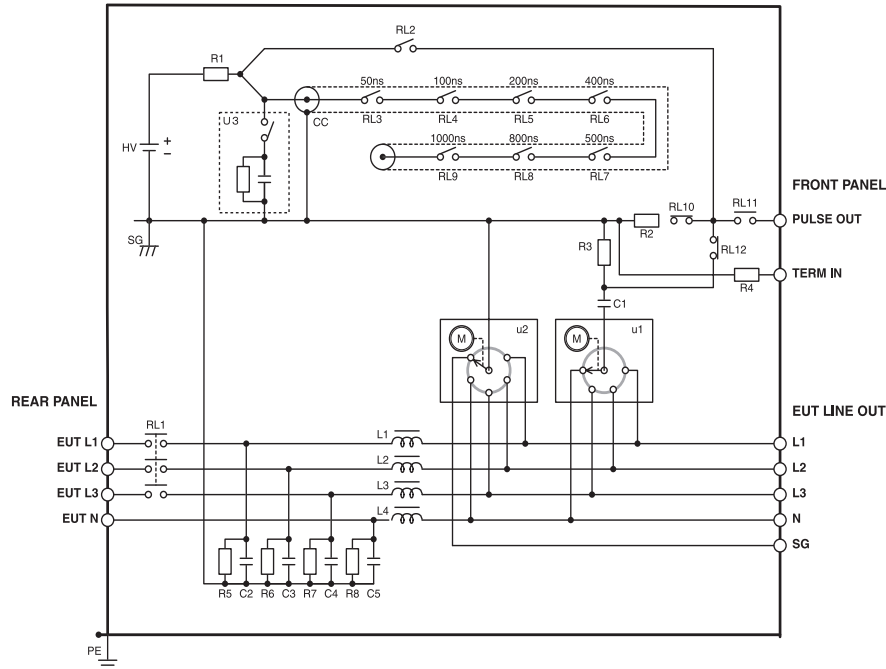
## FEATURES

- An innovative, motor driven coaxial switch mechanism eliminates the need to manually plug and unplug coaxial connectors, allowing a preset test sequence to be carried out seamlessly including pulse width and coupling mode changes, automatic voltage ramp and others.
- As well as manual control, the simulator can be remote-controlled through a fiber optic computer interface. A Windows control software package is supplied as an included accessory.
- Floating output
- 8 pulse widths installed: 10ns, 50ns, 100ns, 200ns, 400ns, 500ns, 800ns and 1000ns
- Internal switchable terminators
- Easily changeable and safety-interlocked outlet panel (EUT interface)
- 3 channels EUT fail input

## CONTROL PANEL



INS-AX2 series 220/420/250/450



INS-AX2-250/450 (4-wire 3-phase) schematic

- HV: high voltage supply
- R1: charging resistor
- R2, R3: terminating resistor
- R4: terminating resistor for externally connected coupling adapter
- C1: coupling capacitor
- CC: coaxial cable
- RL1: contactor
- RL2: mercury relay
- RL3 to RL9: coaxial reed relays, for pulse width selection
- RL10: relay for terminator setting
- RL11: relay for PULSE OUT (turns on when an external device is used)
- RL12: relay for EUT line coupling
- U1: motor driven coaxial switch unit, for coupled line selection
- U2: motor driven coaxial switch unit, for signal return line selection
- U3: triangular wave unit (factory option)
- L1 to L4, R5- to R8 and C2 to C5: components to form LC filter circuitry.

For the basic INS series simulators operating principle, refer to page 9.

The above schematic illustrates how the INS-AX2 series simulators have achieved complete elimination of the operator's intervention in terms of manual plugging and unplugging of coaxial connectors.

The coaxial reed relay RL3 to RL9 work to form given lengths of the charged coaxial line. The pulse width of 10ns is available when all these relays are open. In contrast, the unit generates the 1000ns width pulse with all the relays closed.

The relays RL10, RL11 and RL12 select the route of the pulse output between PULSE OUTPUT and EUT LINE OUT as well as the termination method.

The units U1 and U2 are controlled and provide all the combinations of the coupling modes.

The above schematic shows the states of the relays and switches for the sep-up of:

10ns pulse width, charged line 50-ohm terminated, interference signals coupled in common mode (of N to SG).

**INS-AX2 series 220/420/250/450**
**■ SPECIFICATIONS**

Parameters		specifications
Pulse output voltage		0.01 ~ 2.00kV±10%(220/250) at 0.01kV step 0.01 ~ 4.00kV±10%(420/450) at 0.01kV step ±0.04kV allowance for <0.1kV setting When the output is terminated by the internal resistors.
Output polarity		Positive /Negative
Pulse	Pulse width	50,100,200,400,500,800,1000ns ±10%, 10ns ±3ns
	Rise time	<1 ns
	Output impedance	50Ω system (53. 5Ω)
Pulse repetition mode	PHASE	Injection phase angle 0 to 360 degrees±10 degrees EUT power supply : > AC90V, 50Hz/60Hz±10%.
	VALIABLE	10ms ~ 999ms ±10%(220/250) 16ms ~ 999ms ±10%(420/450)
	1SHOT	Single pulse generation, each time the 1 SHOT button is pressed. Synchronized output with phase angle setting in PHASE mode
Power capacity of EUT		Single phase AC240V/DC65V, 20A(220/420) 3-phase (4-wire) AC500V/DC250V, 50A(250/450) 50/60Hz±10%
Power supply		AC100 ~ 240V±10% 50Hz/60Hz±10%
Power consumption		110VA
Operating temperature		15 ~ 35°C
Operating humidity		25 ~ 75%
Dimensions (mm)		W 430×H 350×D 470 mm, projection excluded
Weight		Approx. 30kg (220/420) Approx. 38kg (250/450)
Mercury relay unit		Models 04-00014A and 04-00015A for 2kV and 4kV models, respectively

**■ Triangular pulse addition (Factory Option)**

Parameters		specifications
Output pulse waveform		Triangular pulse
Pulse output voltage		2kV (220/250) and 4kV (420/450) max (when the output is terminated by the internal resistors)
Output polarity		Positive /Negative
Pulse	Duration	1μs ± 30 %
	Rise time	<40 ns

When the triangular pulse generator has been built-in, the original model numbers become INS-AX2-220T/420T/250T/450T with an affix of "T"

## INS-AX2 series 220/420/250/450

### Remote Control Software (Included accessory)

Complete, comprehensive ready-made Windows software to control the INS-AX2 simulator remotely from your PC. To be free from the EM interference from the simulator, an optical fiber cable and conversion adapter for your PC are included.

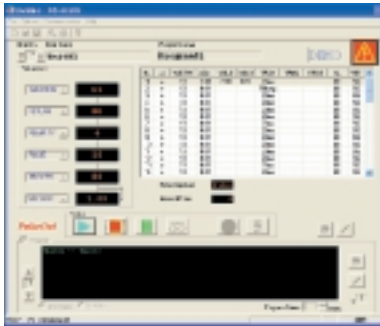
- Controls INS-AX2 via a personal computer.
- Easily creates and manages tests and sequence of tests.
- Manual mode test offers static tests. Sweep mode test offers tests at ramped voltages and placement phase angles or repetition periods. Program mode provides the selected sequence of tests.
- Test report generation, preview and printing are available.



Test set up Window

All test parameters can be set in this window. In Sweep mode, the order of parameters to be ramped can be changed; Voltage changes first or either Phase or Variable changes first.

A complete set of all test parameters settings is called "Unit". One unit can be a Manual test or a Sweep test. In Program test, units can be freely combined and run according to the user-defined sequence.



Test run Window

While the Program test is run, "units" are listed. The unit currently done is highlighted for easier identification.

### OPTIONAL ACCESSORIES FOR INS-AX2 series

#### Outlet Panel MODEL:18-00069A



JP/USA type  
AC125V/20A max

#### Outlet Panel MODEL:18-00071A



Multi type  
AC240V/15A max

#### Circuit breaker box MODEL:18-00073A

3-phase AC415V/50A 50/60Hz

#### Mercury relay unit for replacement

Model: 04-00014A for INS-AX2-220, 250  
Model: 04-00015A for INS-AX2-420, 450

#### Outlet Panel MODEL:18-00070A



CEE7/Schuko type  
AC240V/16A max

#### Circuit breaker box MODEL:18-00072A



Single phase AC240V/20A 50/60Hz, DC65/20A

#### Optical Interface Box MODEL:07-00022A



# INS-4020 and INS-4040

The NoiseKen's INS-4020/4040 is a further development from our versatile INS series simulators for greater ease of use, durability and reliability with new technology specifically applied to this new product. The most significant addition is automatic ramp operation in output voltage, pulse repetition period and phase angle placement.

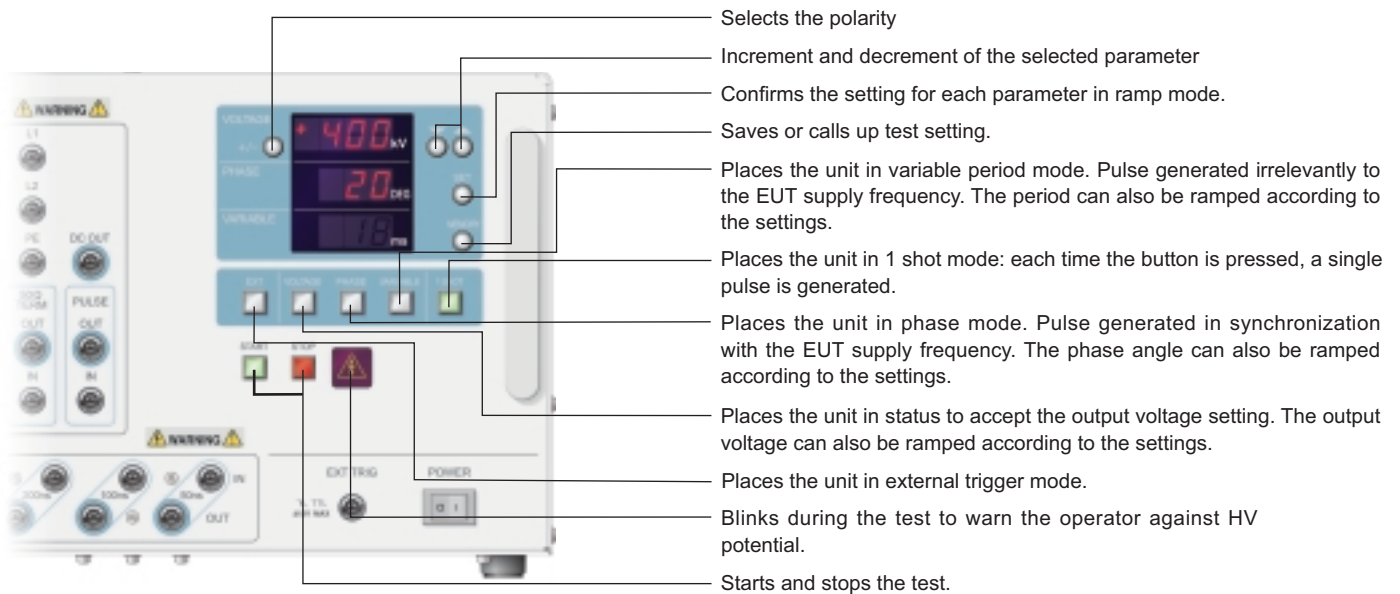


INS-4020

## FEATURES

- Automatic ramp operation for output voltage, phase angle and repetition period
- Floating output
- Coupling mode selection by plugging the supplied coaxial connector to the selected port
- Easily changeable mercury relay
- Built-in 50-ohm terminator
- Up to 5 test settings can be stored in the memory
- Easily changeable outlet panel

## CONTROL PANEL



## STANDARD ACCESSORIES

Description	Quantity	Note
Coaxial cable 02-00013A	8	30cm length
SG short plug 02-00106A	1	
Outlet panel (Terminal block type) 18-00061B	1	AC240V/16A DC60V/16A maximum Leaves the factory with this panel attached to the main unit.
Instruction manual	1	

## INS 4020 and 4040

### INS-4020/4040 SPECIFICATIONS

Parameters		INS-4020	INS-4040
Output voltage		0.01~2.00kV ±10% with 50Ω Load (±0.04kV for <0.1kV)	0.01~4.00kV ±10% with 50Ω Load (±0.04kV for <0.1kV)
Polarity		Positive or negative	
Square wave	Pulse width	50ns, 100ns, 200ns, 250ns, 400ns and any combination thereof, maximum width 1μs, or 10ns±3ns (the shortest connection)	
	Rise time	<1ns	
	Output impedance	50Ω system (53.5Ω)	
Pulse repetition mode	PHASE	50 or 60Hz, Injection phase angle 0~359°(Synchronized with L1, L2 of power supply to be injected, or external terminal.)	
	VARIABLE	10ms ~ 999ms ±10%	16ms ~ 999ms ±10%
	EXT	>10ms TTL/Open collector negative logic	>16ms TTL/Open collector negative logic
	1 SHOT	By trigger switch, a single pulse injection to any phase angle of the power line	
Power capacity of EUT		AC240V Single phase, DC60V, 16A	
Power supply		100 ~ 240 VAC 50/60 Hz	
Power consumption		140VA	
Operating temperature and humidity		15 ~ 35°C 25 ~ 75% (No dewing shall occur.)	
Dimensions and weight		(W)430 x (H)249 x (D)420 mm (Projections excluded) / Approx. 19 kg	

### OPTIONAL ACCESSORIES FOR INS-4020/4040

#### Injection Unit MODEL:IJ-4050



Input voltage: 8,000V (without 50Ω terminated)  
 EUT power capacity: 3-phase/5-wire AC415V/50A  
 Coupling selection: By connecting cable  
 Coupling mode: Normal or Common mode by SG short plug  
 Line synchronization: Detects L1-L2 voltage and outputs the synchronization signal from SYNC OUT terminal  
 Coupling attenuation characteristic: <-10dB ~ 1GHz  
 Power supply: AC100~240V 50/60Hz 20VA max

#### Triangular wave unit MODEL:02-00099A



Pulse shape: Triangular wave  
 Pulse voltage: 4,000V (with 50Ω terminated)  
 Pulse width: 1μs ±30%  
 Rise time: <40ns  
 Polarity: Positive or negative

#### Outlet Panel MODEL:18-00059C



JP/USA type  
 AC125V/20A max

#### Outlet Panel MODEL:18-00060B



CEE7 Schuko type  
 AC240V/16A max

#### Outlet Panel MODEL:18-00061B



Terminal block type  
 AC240V/16A, DC60V/16A

#### Circuit breaker box MODEL:18-00072A



Single phase AC240V/20A 50/60Hz, DC65V/20A

#### Mercury relay unit for replacement MODEL:INS-RL2K for INS-4020

#### Mercury relay unit for replacement MODEL:INS-RL4KB for INS-4040



*INS series*

**OPTIONAL ACCESSORIES FOR INS**

**■ Coupling Adapter Model:CA-805B**



Input voltage: 4,000V max  
 Input pulse width: 50n~1 μs  
 Diameter for clamping cable: 26mm max

**■ Coupling Adapter MODEL:CA-803A**



Input voltage: 2,000V max  
 Input pulse width: 50n~1 μs  
 Coupling ratio: 20:1  
 Terminator: 50Ω terminator built-in  
 Diameter for clamping cable: 15mm max

**■ EMS Probe Kit MODEL:Model: H2-B**



A diagnostic tool for locating sensitive spots on the circuits under test to the electric or magnetic transient field. This kit consists of 3 electric and 3 magnetic field probes, all in a different probe head size for a variety of applications. Connected to the INS or FNS (Electrical Fast Transient Burst) simulator, each probe works as a transient field source.

Features  
 Detects possible noise immunity problem spots  
 Generates transient electrical or magnetic fields  
 Application for modules, components, conductors and ICs  
 Convenient handling by pencil shape, light plug-type cable with snap-action coupling

**■ Radiation Probe Model:01-00006A ~ 10A**



Input voltage: 4,000V max  
 Input pulse width: 50n~1 μs  
 Loop diameter: 50, 75, 100, 150, 200mm  
 Cable length: Approx. 2m

**■ Coupling Adapter CA-806 Model:15-00007A**



Input voltage: 2,000V max  
 Input pulse width: 50n~1 μs  
 Coupling ratio: 10:1  
 Terminator: 50Ω terminator built-in  
 Diameter for clamping cable: 27mm max

**■ Attenuator for waveform observation MODEL:AT-810**

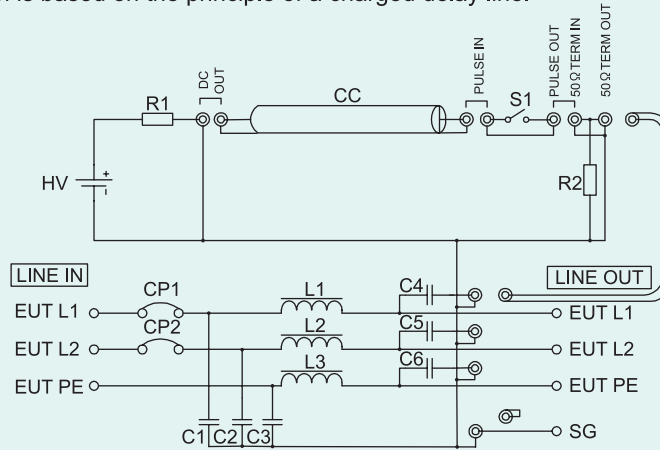


Input voltage: 4,000V max  
 Input pulse width: 50n~1 μs  
 Attenuation: 1:100 (40dB)  
 Input impedance: 50Ω  
 Output impedance: 50Ω  
 Frequency characteristics: DC to 500MHz (-4dB)

## INS 4020 and 4040

### INS SERIES ELECTRICAL SCHEMATIC

The simulator design is based on the principle of a charged delay line.



- HV: HV power supply
- S1: Mercury relay
- C4,5,6: Coupling capacitor
- L1/C1,L2/C2,L3/C3: Filter
- R1: Charging resistor
- R2: Termination resistor
- CP1,2: Circuit breaker
- CC: Coaxial cable

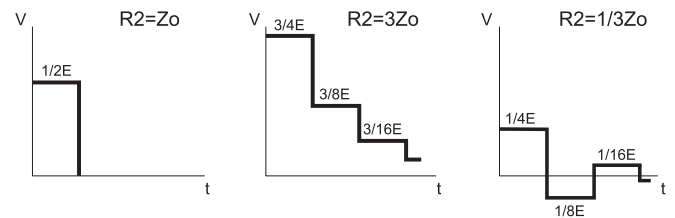
### PULSE GENERATION PRINCIPLE

The main components of the pulse generator circuitry of this unit are coaxial cables, HV power supply, charging resistor, mercury relay, and terminating resistor. The coaxial cables form a distributed constant circuit consisting of the inductance of the inner conductor and capacitance between the inner and outer conductors. When this line is terminated by a 50Ω resistance, it works as a square wave pulse generator. Pulse widths vary depending on the delay time of the coaxial line (length of the cable). The proportion of pulse widths to the length is approximately 10 ns per meter. Pulse waveforms and amplitudes depend on the relation between terminator resistance and coaxial cable characteristic impedance.

The HV power supply charges up the capacitance component of the coaxial line through the charging resistor when the mercury relay is in off status. The stored energy is discharged when the mercury relay contacts turn on, generating a HV square wave pulse across the 50Ω terminating resistor. The injection unit couples this pulse through a capacitor to an EUT LINE. Also provided is a decoupling circuit consisting of an inductor and a capacitor, working as a high impedance circuit when seen from the injection point. This enables the unit to effectively couple the interference signals to the EUT and to reduce their leakage into the power supply side (LINE IN).

### FOR PERFECT MATCHING

Pulse waveforms and amplitudes are dependent on the value of a termination resistor being connected to the PULSE OUT terminal. The figures and equation shown at the right show their relations. To generate square wave pulses, this unit adopts a 50Ω (strictly, 53.5Ω resistance), an equal value to the characteristic impedance of the coaxial cables.



$$V_p = R_2 / (Z_0 + R_2) \times E$$

$V_p$ : Peak voltage being measured across the terminating resistor

$R_2$ : Value of terminating resistor

$Z_0$ : Characteristics impedance of the cable

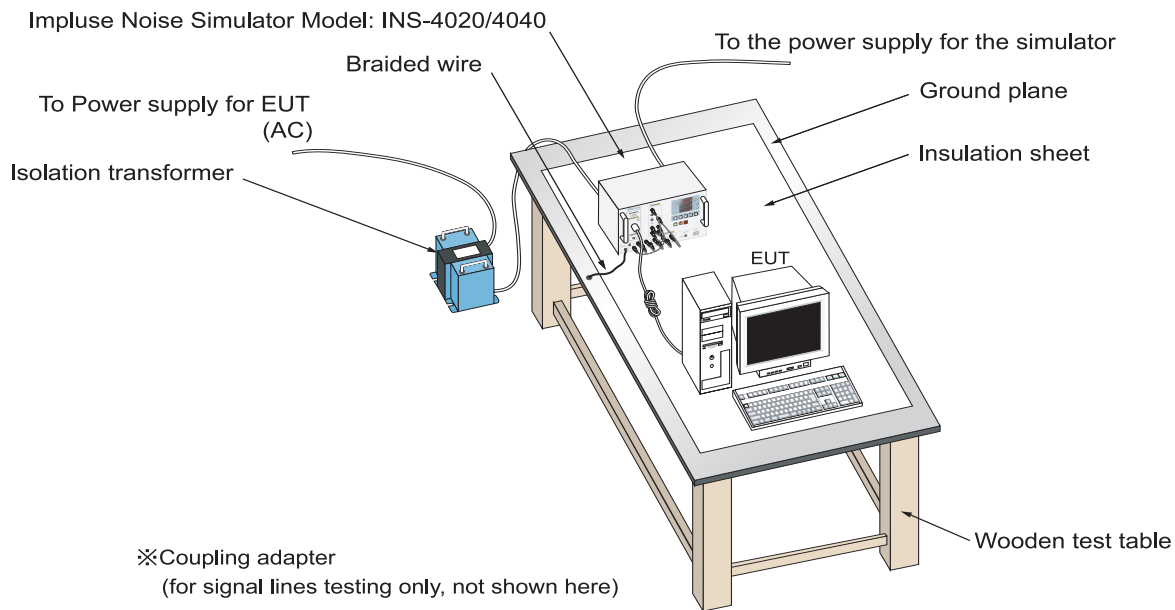
$E$ : Output voltage from the HV power supply

## INS 4020 and 4040

### OUTLINES OF TEST SET-UP (EXAMPLE: INS-4020/4040)

#### Test environments

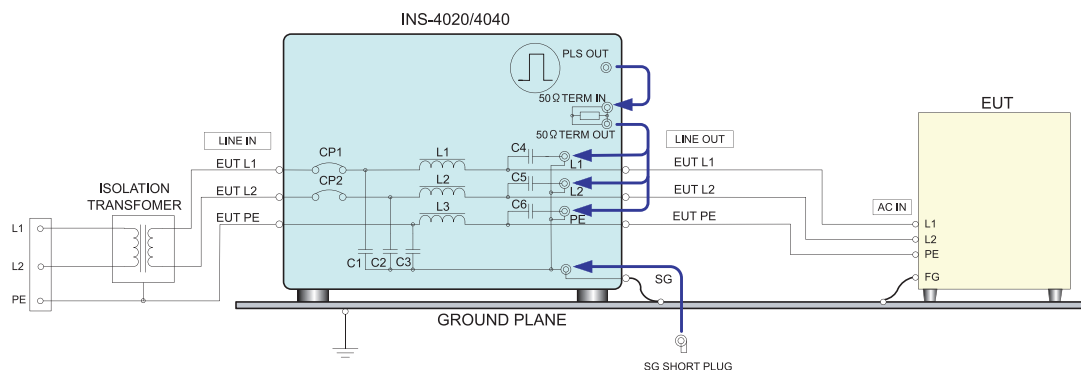
A recommended test set-up example is shown here.



(Notice) EUT LINE INPUT for AC powered testing shall be power-fed from an isolation transformer. Place a ground plane beneath the simulator and EUT. The plane shall be grounded for safety.

### TEST SET-UP

#### Line to ground mode (common mode) for AC operated equipment

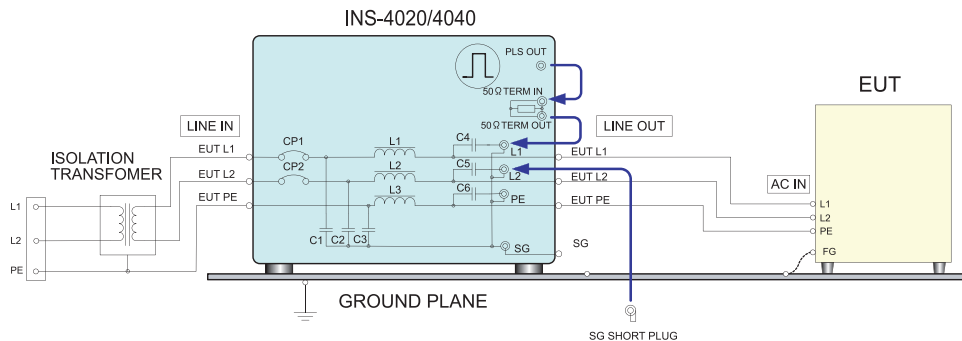


- (1) Mount the OUTLET PANEL matching the EUT and then plug the EUT AC cord to the panel receptacle. In case the AC cord is too long, fold it so that it might not cross with signal or other cables.
- (2) Plug the SG (=signal ground) connector with the SG short plug.
- (3) Connect the SG terminal of this unit and FG (=frame ground) terminal of the EUT to the ground plane by using low impedance wires, for example, braided wire of 3.5mm<sup>2</sup> of the shortest possible length.
- (4) In case the EUT consists of plural units, each unit shall be connected to the ground plane.
- (5) When the EUT does not have FG terminal, testing shall be done with the EUT ungrounded to the ground plane.
- (6) Select the line to which the pulses are to be injected by making a connection from 50Ω TERM OUT terminal to the EUT LINE L1 (L2 or PE) by using a supplied coaxial cable.

## INS 4020 and 4040

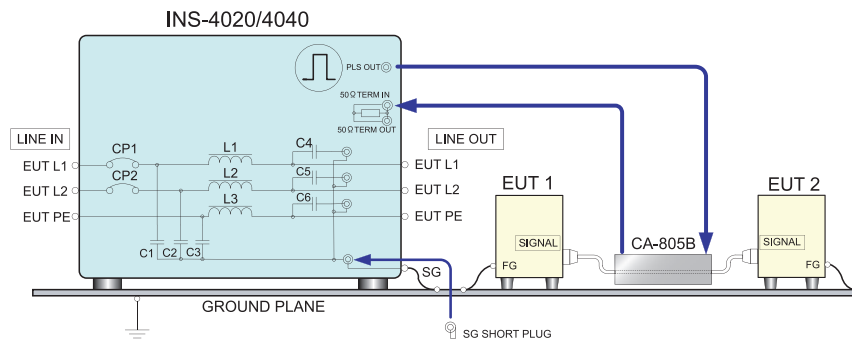
### TEST SET UP

#### Line to line (normal mode) for AC operated equipment



- (1) Mount the OUTLET PANEL matching the EUT and then plug the EUT AC cord to the panel receptacle. In case the AC cord is too long, fold it so that it might not cross with signal or other cables.
- (2) Testing shall be done with the SG terminal not being connected to the ground plane. In case the EUT have an FG terminal, test it both with the FG connected to the ground plane and with the FG disconnected from the plane.
- (3) Select the line to which the pulses are to be injected by making a connection from 50ΩTERM OUT terminal to the EUT LINE L1 (or L2) by using a supplied coaxial cable.
- (4) Plug the L2 (or L1) connector with the SG short plug, while the SG connector shall remain open circuit.

#### Capacitive coupling test for signal lines (by using CA-805B coupling adapter)



- (1) Open the coupling adapter (option) and clamp the interface cable under test. The PULSE OUT terminal shall be connected to one side of the adapter and the 50ΩTERM IN terminal shall be connected to the other side. (Changing the injection and termination sides is also recommended as test results may vary.)
- (2) EUT power can be supplied from the service outlet directly, as the HV pulses are not injected to these lines.
- (3) Connect the SG terminal of this unit and FG terminal of each unit of the EUT to the ground plane.

Designs and specifications are subject to change without notice.

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