



Indirect Lightning Induced Transient Susceptibility Test System

LSS 160SM8 & ETS160M8

- RTCA/DO-160G S22
- MIL-STD-461G
- AECTP 250
- AECTP 500
- GJB 8848-2016
- HB 6167.24

Features

- > Modular design, the waveform module is detachable
- > Capable of generating 6 kinds of waveforms and performing pins injection test and cable bundle test
- > 5.7" color touch screen with easy and distinct operation control
- > Phase sync function in signal pins & power pins-direct injection method
- > Corelab software is available for remote control

Introduction

When an aircraft is flying in severe convection environment, it will be frequently affected by lightning stroke, which will generate transient induced voltage or current on circuits and cables of airborne equipment, such phenomenon is called indirect lightning effect. It may make the aircraft get out of control, even bring about fuselage fire and other serious accidents. For safety reasons, the airborne equipment must be designed properly and tested completely to ensure the system and equipment with critical safety function to perform normally and its flight security when the aircraft is influenced by lightning stroke.

The LSS 160SM8 and ETS 160MB test systems are designed according to RTCA/DO-160 Section 22, The LSS 160SM8 is capable of generating waveforms 1,4 and 5A/5B, and ETS 160MB is of waveforms 2, 3 and 6. Both test level are from 1 to 5 for pins injection test and cable bundle test; Additionally, the test system is not only meet the test requirement of lightning induced transients conducted susceptibility in MIL-STD-461G CS117.

The ETS 160MB test system includes various test auxiliary equipment to make it convenient to conduct tests, such as coupling transformer, power blocking device, transient blocking device, pin injection probe, external DC capacitor etc. What's more, the Corelab software is also available for test remote control, which makes your test easy and convenient.

Application Areas



Technical Parameters for LSS 160SM8

Current Waveform 1 Cable Bundle Cable Induction

For tests as per DO-160G S22, MIL-STD-461G CS117(WF2/1) etc.

Coupling Mode	Cable Induction (CI)
Output Module	WAVE 1-CI/GI
Current Waveform 1	6.4 μ s $\pm$ 20 % / 69 μ s $\pm$ 20 %
Single Stroke Output	50 A ~ 4,200 A (-0% ~ +20%); Output impedance $\leq$ 0.5 Ω
Multiple Stroke Output	50 A ~ 2,000 A (-0% ~ +20%) (first stroke); Output impedance $\leq$ 0.5 Ω
	25 A ~ 1,000 A (-0% ~ +50%) (subsequent stroke); Output impedance $\leq$ 0.5 Ω
Number of Subsequent Pulses	1 ~ 14
Interval of Subsequent Pulses	10 ms ~ 200 ms, random mode is available
Polarity	Positive or negative
Number of Test Times	1 ~ 99
Test Repetition	10 s ~ 99 s (shortest time depends on output amplitude)
Coupler	LCT-L5B

Current Waveform 1 Cable Bundle Ground Injection

For tests as per DO-160G S22 etc.

Coupling Mode	Ground Injection (GI)
Output Module	WAVE 1-CI/GI
Current Waveform 1	6.4 μ s $\pm$ 20 % / 69 μ s $\pm$ 20 %
Single Stroke Output	50 A ~ 4,200 A (-0% ~ +20%); Output impedance $\leq$ 0.5 Ω
Multiple Stroke Output	50 A ~ 2,000 A (-0% ~ +20%) (first stroke); Output impedance $\leq$ 0.5 Ω
	25 A ~ 1,000 A (-0% ~ +50%) (subsequent stroke); Output impedance $\leq$ 0.5 Ω
The Number of Subsequent Pulses	1 ~ 14
Interval of Subsequent Pulses	10 ms ~ 200 ms, random mode is available
Polarity	Positive or negative
Number of Test Times	1 ~ 99
Test Repetition	10 s ~ 99 s (shortest time depends on output amplitude)
Max. EUT Power Supply	AC 230 V / 32 A 50/60 Hz; DC 230 V/32 A
Coupler	LCT- L5B

Technical Parameters for LSS 160SM8

Voltage Waveform 4 Signal Pins & Power Pins Direct Injection

For tests as per DO-160G S22 etc.

Coupling Mode	Pins Direct Injection (PDI)
Output Module	WAVE 4-PI
Output Impedance	5 Ω $\pm$ 10 %
Voltage/Current Waveform 4	6.4 μ s $\pm$ 20 % / 69 μ s $\pm$ 20 %
Output Voltage	50 V ~ 3,000 V (-0% ~ +10%), (open circuit)
Output Current	10 A ~ 600 A (-0% ~ +10%), (short circuit)
Polarity	Positive or negative
Number of Test Times	1 ~ 99
Test Repetition	10 s ~ 99 s (shortest time depends on output amplitude)
EUT Power Supply	Max. 230 V
EUT Frequency	Max. 800 Hz
Power Blocking Device	> peak value of signal or power voltage (optional)

Voltage Waveform 4 Cable Bundle Ground Injection

For tests as per DO-160G S22 etc.

Coupling Mode	Ground Injection (GI)
Output Module	WAVE 4-CI/GI
Voltage Waveform 4	6.4 μ s $\pm$ 20 % / 69 μ s $\pm$ 20 %
Single Stroke Output	50 V ~ 3,000 V (-0% ~ +20%); Output impedance $\geq$ 0.5 Ω
Multiple Stroke Output	25 V ~ 1,000 V (-0% ~ +20%) (first stroke); Output impedance $\geq$ 0.5 Ω
	10 V ~ 500 V (-0% ~ +50%) (subsequent stroke); Output impedance $\geq$ 0.5 Ω
The Number of Subsequent Pulses	1 ~ 14
Interval of Subsequent Pulses	10 ms ~ 200 ms, random mode is available
Polarity	Positive or negative
Number of Test Times	1 ~ 99
Test Repetition	10 s ~ 99 s (shortest time depends on output amplitude)
Max. EUT Power Supply	AC 230 V / 32 A 50/60 Hz; DC 230 V/32 A
Coupler	LCT-L5B

Technical Parameters for LSS 160SM8

Voltage Waveform 4 Cable Bundle Cable Injection	
For tests as per DO-160G S22 etc.	
Coupling Mode	Cable Induction (CI)
Output Module	WAVE 4-CI/GI
Voltage Waveform 4	6.4 μ s $\pm$ 20 % / 69 μ s $\pm$ 20 %
Single Stroke Output	50 V ~ 3,000 V (-0% ~ +20%); Output impedance $\geq$ 0.5 Ω
Multiple Stroke Output	25 V ~ 1,000 V (-0% ~ +20%) (first stroke); Output impedance $\geq$ 0.5 Ω
	10 V ~ 500 V (-0% ~ +50%) (subsequent stroke); Output impedance $\geq$ 0.5 Ω
The Number of Subsequent Pulses	1 ~ 14
Interval of Subsequent Pulses	10 ms ~ 200 ms, random mode is available
Polarity	Positive or negative
Number of Test Times	1 ~ 99
Test Repetition	10 s ~ 99 s (shortest time depends on output amplitude)
Coupler	LVT-L5B
Voltage Waveform 5A Signal Pins & Power Pins Direct Injection	
For tests as per DO-160G S22 etc.	
Coupling Mode	Pins Direct Injection (PDI)
Output Module	WAVE 5A-PI
Output Impedance	1 Ω $\pm$ 10 %
Voltage/Current Waveform 5A	40 μ s $\pm$ 20 % / 120 μ s $\pm$ 20 %
Output Voltage	50 V ~ 3,000 V (-0% ~ +10%) (open circuit)
Output Current	50 A ~ 3,000 A (-0% ~ +10%) (short circuit)
Polarity	Positive or negative
Number of Test Times	1 ~ 99
Test Repetition	10 s ~ 99 s (shortest time depends on output amplitude)
EUT Power Supply	Max. 230 V
EUT Power Frequency	Max. 800 Hz
Power Blocking Device	> peak value of signal or power voltage (optional)

Technical Parameters for LSS 160SM8

Current Waveform 5A Cable Bundle Cable Induction	
For tests as per DO-160G S22, MIL-STD-461G CS117(WF4/5A) etc.	
Coupling Mode	Cable Induction (CI)
Output Module	WAVE 5A-CI/GI
Current Waveform 5A	$40 \mu\text{s} \pm 20\%$ / $120 \mu\text{s} \pm 20\%$
Single Stroke Output	50 A ~ 10,000 A (-0% ~ +20%); Output impedance $\leq 0.3 \Omega$
Multiple Stroke Output	50 A ~ 2,000 A (-0% ~ +20%) (first stroke); Output impedance $\leq 0.3 \Omega$
	25 A ~ 1,000 A (-0% ~ +50%) (subsequent stroke); Output impedance $\leq 0.3 \Omega$
Number of Subsequent Pulses	1 ~ 14
Interval of Subsequent Pulses	10 ms ~ 200 ms, random mode is also available
Polarity	Positive or negative
Number of Test Times	1 ~ 99
Test Repetition	10 s ~ 99 s (shortest time depends on output amplitude)
Coupler	LCT-L5B
Current Waveform 5A Cable Bundle Ground Injection	
For tests as per DO-160G S22, MIL-STD-461, CS117(WF4/5A) etc.	
Coupling Mode	Cable Induction (GI)
Output Module	WAVE 5A-CI/GI
Current Waveform 5A	$40 \mu\text{s} \pm 20\%$ / $120 \mu\text{s} \pm 20\%$
Single Stroke Output	50 A ~ 10,000 A (-0% ~ +20%); Output impedance $\leq 0.3 \Omega$
Multiple Stroke Output	50 A ~ 2,000 A (-0% ~ +20%) (first stroke); Output impedance $\leq 0.3 \Omega$
	25 A ~ 1,000 A (-0% ~ +50%) (subsequent stroke); Output impedance $\leq 0.3 \Omega$
Number of Subsequent Pulses	1 ~ 14
Interval of Subsequent Pulses	10 ms ~ 200 ms, random mode is also available
Polarity	Positive or negative

Technical Parameters for LSS 160SM8

Current Waveform 5A Cable Bundle Ground Injection	
Number of Test Times	1 ~ 99
Test Repetition	10 s ~ 99 s (shortest time depends on output amplitude)
EUT Power Supply	Max. AC 230 V / 32 A 50/60 Hz; DC 230 V/32 A
Coupler	LCT-L5B
Current Waveform 5B Signal Pins & Power Pins Direct Injection	
For tests as per DO-160G S22 etc.	
Coupling Mode	Pins Direct Injection (PDI)
Output Module	WAVE 5B-PI
Voltage/Current Waveform 5B	1 $\Omega \pm 10 \%$
Single Stroke Output	50 $\mu\text{s} \pm 20 \%$ / 500 $\mu\text{s} \pm 20 \%$
Multiple Stroke Output	50 V ~ 1,600 V (-0% ~ +10%) (open circuit)
	50 A ~ 1,600 A (-0% ~ +10%) (short circuit)
Polarity	Positive or negative
Number of Test Times	1 ~ 99
Test Repetition	10 s ~ 99 s (shortest time depends on output amplitude)
EUT Power Supply	Max. AC/DC 230 V
EUT Power Frequency	Max. 800 Hz
Power Blocking Device	> peak value of signal or power voltage (optional)
Current Waveform 5B Cable Bundle Cable Induction	
For tests as per DO-160G S22	
Coupling Mode	Cable Injection (CI)
Output Module	WAVE 5B-CI/GI
Current Waveform 5B	50 $\mu\text{s} \pm 20 \%$ / 500 $\mu\text{s} \pm 20 \%$
Single Stroke Output	50 A ~ 5,000 A (-0% ~ +20%) Output impedance $\leq 0.3 \Omega$
Multiple Stroke Output	50 A ~ 2,000 A (-0% ~ +20%) (first stroke); Output impedance $\leq 0.3 \Omega$
	25 A ~ 1,000 A (-0% ~ +50%) (subsequent stroke); Output impedance $\leq 0.3 \Omega$

Technical Parameters for LSS 160SM8

Current Waveform 5B Cable Bundle Cable Induction	
Number of Subsequent Pulses	1 ~ 14
Interval of Subsequent Pulses	30 ms ~ 200 ms, random mode is also available
Polarity	Positive or negative
Number of Test Times	1 ~ 99
Test Repetition	10 s ~ 99 s (shortest time depends on output amplitude)
Coupler	LCT-L5B
Current Waveform 5B Cable Bundle Ground Injection	
For tests as per DO-160G S22	
Coupling Mode	Ground Injection (GI)
Output Module	WAVE 5B-CI/GI
Current Waveform 5B	50 μ s $\pm$ 20 % / 500 μ s $\pm$ 20 %
Single Stroke Output	50 A ~ 5,000 A (-0% ~ +20%); Output impedance $\leq$ 0.3 Ω
Multiple Stroke Output	50 A ~ 2,000 A (-0% ~ +20%) (first stroke) Output impedance $\leq$ 0.3 Ω
	25 A ~ 1,000 A (-0% ~ +50%) (subsequent stroke); Output impedance $\leq$ 0.3 Ω
Number of Subsequent Pulses	1 ~ 14
Interval of Subsequent Pulses	10 ms ~ 200 ms, random mode is also available
Polarity	Positive or negative
Number of Test Times	1 ~ 99
Test Repetition	10 s ~ 99 s (shortest time depends on output amplitude)
EUT Power Supply	Max. AC 50/60 Hz 230 V / 32 A; DC 230 V/32 A
Coupler	LCT-L5B

List of Waveform Module and Test Type

Waveform Module	Test Type
WAVE 1-CI/GI	Current waveform 1-cable bundle cable induction test Current waveform 1-cable bundle ground injection test
WAVE 4-PI	Voltage waveform 4-signal pins & power pins direct injection method
WAVE 4-CI/GI	Voltage waveform 4-cable bundle cable induction test Voltage waveform 4-cable bundle ground injection test
WAVE 5A-PI	Voltage waveform 5A-signal pins & power pins direct injection method
WAVE 5A-CI/GI	Current waveform 5A-cable bundle cable induction test Current waveform 5A-cable bundle ground injection test
WAVE 5B-PI	Voltage waveform 5B-signal pins & power pins direct injection method
WAVE 5B-CI/GI	Current waveform 5B-cable bundle cable induction test Current waveform 5B-cable bundle ground injection test

Technical Parameters for ETS 160MB

Voltage Waveform 2 Cable Bundle Cable Induction Tests	
Coupling Mode	Cable Induction
Output Module	WAVE 2
Rise Time	< 100 ns
Duration	6.4 μ s $\pm$ 20%
Polarity	Positive or negative
Coupling Transformer	LVT-2
Single Stroke	
Test Level	50 V ~ 2,000 V (-0% ~ +20%)
Pulse Repetition	0.1 s ~ 9.9 s
Pulse Number	1 ~ 9,999
Multiple Stroke	
Test Level	50 V ~ 2,000 V (-0% ~ +20%) (first stroke) 25 V ~ 1,000 V (-0% ~ +50%) (subsequent stroke)
Pulse Repetition	10 ms ~ 200 ms
Pulse Number	1~14
Multiple Stroke Repetition	1.5 s ~ 9.9 s
Multiple Stroke Number	1 ~ 9,999

Technical Parameters for ETS 160MB

Voltage Waveform 3 (1MHz) Signal Pins & Power Pins Injection Tests	
Coupling Mode	Pin Injection
Output Module	WAVE 3-1MHz-PI
Output Impedance	25 Ω
Frequency	1 MHz $\pm$ 20 %
Decay Rate of 5th Waveshape	25% ~ 75%
Test Level for Single Stroke Tests	100 V ~ 4,500 V (-0% ~ +10%)
	4 A ~ 180 A (-0% ~ +10%) (short-circuit current)
Pulse Repetition	0.1 s ~ 9.9 s
Polarity	Positive or negative
Phase Sync	0° ~ 359°, resolution 1°
EUT Power Supply	Max. AC 230 V, DC $\pm$ 50 V
EUT Power Frequency	800 Hz
Voltage Waveform 3 (1 MHz) Cable Bundle Cable Induction Tests	
Coupling Mode	Cable Induction
Output Module	WAVE 3-1MHz & WAVE 3-1MHz-MB
Frequency	1 MHz $\pm$ 20%
Decay Rate of 5th Waveshape	25% ~ 75%
Test Level for Single Stroke Tests	50 V ~ 4,500 V (-0% ~ +20%)
Polarity	Positive or negative
Voltage Coupling Transformer	LVT-2
Single Stroke (WAVE 3-1MHz)	
Test Level	50 V ~ 4,500 V (-0% ~ +20%)
Pulse Repetition	0.1 s ~ 9.9 s
Pulse Number	1 ~ 9,999
Multiple Stroke (WAVE 3-1MHz)	
Test Level	50 V ~ 4,500 V (-0% ~ +20%) (first stroke)
	50 V ~ 2,250 V (-0% ~ +50%) (subsequent stroke)
Pulse Repetition	10 ms ~ 200 ms
Pulse Number	1~14
Multiple Stroke Repetition	1.5 s ~ 9.9 s
Multiple Stroke Number	1 ~ 9,999

Technical Parameters for ETS 160MB

Voltage Waveform 3 (1 MHz) Cable Bundle Cable Induction Tests	
Multiple Burst (WAVE 3-1MHz-MB)	
Test Level	60 V ~ 1,920 V (-0% ~ +20%)
Output Impedance	$\geq 60 \Omega$
Voltage Waveform 3 (10 MHz) Cable Bundle Cable Induction Tests	
Coupling Mode	Cable Induction (CI)
Output Module	WAVE 3-10MHz
Frequency	10 MHz $\pm$ 20 %
Decay Rate of 5th Waveshape	25% ~ 75%
Polarity	Positive or negative
Coupling Transformer	LVT-2
Single Stroke	
Test Level	50 V ~ 4,000 V (-0% ~ +20%)
Pulse Repetition	0.1 s ~ 9.9 s
Pulse Number	1 ~ 9,999
Multiple Stroke	
Test Level	50 V ~ 4,000 V (-0% ~ +20%) (first stroke) 50 V ~ 2,000 V (-0% ~ +50%) (subsequent stroke)
Pulse Repetition	10 ms ~ 200 ms
Pulse Number	1 ~ 14
Multiple Stroke Repetition	1.5 s ~ 9.9 s
Multiple Stroke Number	1 ~ 9,999
Multiple Burst	
Test Level	60 V ~ 1,920 V (-0% ~ +20%)
Pulse Repetition	50 μ s ~ 1,000 μ s
Pulse Number	1 ~ 20
Burst Repetition	300 ms ~ 900 ms
Burst Number	1 ~ 3
Burst Group Repetition	3 s ~ 10 s
Burst Group Number	1 ~ 200

Technical Parameters for ETS 160MB

Current Waveform 6 Cable Bundle Cable Induction Tests	
Coupling Mode	Cable Induction
Output Module	W6 Module
Current Waveform	5 A ~ 160 A
Rise Time	0.25 μ s $\pm$ 20%
Duration	4 μ s $\pm$ 20%
Coupling Transformer	LVT-3
Pulse Repetition	50 μ s ~ 1,000 μ s
Pulse Number	1 ~ 20
Burst Repetition	300 ms ~ 900 ms
Burst Number	1 ~ 3
Burst Group Repetition	3 s ~ 10 s
Burst Group Number	1 ~ 200

General Parameters

Display	5.7" TFT touch screen
Working Power	220 V, $\pm$ 10%, 50/60Hz
Fuse	10 A
User's Memory Space	Infinite (PC)
Communication Mode	Ethernet LAN, RJ45
Working Status Indication	LED indication and LCD display on front panel
Grounding Connection	Flat grounding wire
Waveform Output Terminal	Banana plug line
Dimension	LSS 160SM6: 600 (L) * 800 (W) * 1,800 (H) mm (35U rack) ETS 160MB: 445 (L) * 690 (W) * 600 (H) mm (4U rack*2)
Weight	LSS 160SM8: Approx. 280 kg ETS 160MB: 41 kg
Ambient Temperature	15 $^{\circ}$ C ~ 35 $^{\circ}$ C
Relative Humidity	45% ~ 75%
Atmospheric Pressure	86 kPa ~ 106 kPa

Standard Accessories

Fuse, Power Line, Flat Grounding Wire, Test Line, Alligator Clip, User Manual, Coaxial Line

Optional Accessories

LSS 160SM8			
1	Line Impedance Stabilization Network	Model: LISN AR 50 The LISN AR 50 is used for isolating electric wave in cable bundle test and supply stable impedance for test system; Max AC 530 V, DC 600 V; I_{rms}: 50 A; Frequency: 10 kHz ~ 400 MHz;	
2	Current Coupling Transformer	Model: LCT-L5B The LCT-L5B is used for coupling current waveforms 1, 5A, 5B and meet the test requirement of single/multiple stroke (level 1~5) test;	
3	External DC Capacitor	Model: C3350 /C33400 The C3350/C33400 is used together with LISN for conducting cable bundle tests; Max. DC voltage is 400 V for C33400, 50 V for C3350; Capacitance: 33,000 μF;	
4	Voltage Coupling Transformer	Model: LVT-L5B The LVT-L5B is used for coupling voltage waveforms 4, 5A and meet the test requirement of single/multiple stroke (level 1 ~ 5) test;	
5	Power Blocking Device	Model: CN 160W4W5/CN 800C32 The power blocking device is used to isolate voltages at the pins of the EUT from the low generator impedance so as to protect the generator; The Max. isolating AC voltage is 400 V, isolating DC voltage is 600 V for CN 160W4W5, 800 V for CN 800C32. Meet the test requirement of powered EUT for conducting pins injection test of waveforms 4, 5A, 5B;	

Optional Accessories

LSS 160SM8			
6	Transient Blocking Device	Model: DN 6020T/DN 8020T The transient blocking device is used to prevent EUT power supply from being damaged by pulses 3, 4, 5A and 5B; EUT Max. AC power supply is 400 V 20 A three-phase, 0 ~ 400 Hz (common mode); DN 6020T: EUT Max. DC power supply is 600 V, 20 A DN 8020T: EUT Max. DC power supply is 800 V, 20 A Meet the test requirement of powered EUT for conducting pins injection test of waveforms 3, 4, 5A, 5B; Note: Both LSS 160SM8 and ETS 160MB share the DN series.	
7	Transient Blocking Device	Model: DN-4200T The DN-4200T is used to prevent EUT power supply from being damaged by waveforms 3, 4, 5A and 5B; Max. AC/DC power supply is 400 V 200 A three phase, 50/60 Hz (common mode); Meet the test requirement of powered EUT for conducting pins injection test of waveforms 3, 4, 5A, 5B;	
8	Digital Oscilloscope	Model: MDO3012 (Tektronix) Frequency: 100 MHz; Sample rate: 1.25 GS/s; Record length: 10 Mb; Note: Both LSS 160SM6 and ETS 160MB share the MDO3012.	
9	Wide-band Current Monitor	Model: CCM 0301M Peak current: 20 kA Frequency: 10 kHz ~ 1 MHz	
10	Differential Probe	Model: THDP0100 (Tektronix) 6 kV differential mode, 100 MHz; The THDP0100 is used for measuring voltage of all waveforms Note: Both LSS 160SM6 and ETS 160MB share the THDP0100.	
11	Corelab Software	The software is used for remote control; > Support connection with oscilloscope for monitoring waveforms; > Support generating test report; Note: Both LSS 160SM8 and ETS 160MB share the Corelab software.	

Optional Accessories

ETS 160MB			
1	Coupling Transformer	Model: LVT-2 The LVT-2 is used to couple voltage of waveform 2 and waveform 3 (1 MHz & 10 MHz); It satisfies single stroke, multiple stroke and multiple burst tests of cable bundle; Test level is from 1 to 5; Max. coupling voltage is 2,000 V for W2; Max. coupling voltage is 4,000 V for W3;	
2	Coupling Transformer	Model: LVT-3 The LVT-3 is used to couple current of waveform 6; It satisfies multiple burst tests of cable bundle; Test level is from 1 to 5; Max. coupling current is 160 A;	
3	Power Blocking Device	Model: CN-2 The CN-2 is used to isolate voltages at the pins of the EUT from the low generator impedance in waveform 3 pins direct injection test;	
4	Handheld Pin Injection Probe	Model: HIP 5000 The probe is used in pin injection tests of waveform 3 (1 MHz); Handheld structure design makes pin injection tests convenient;	
5	Current Divider	Model: MCS 01 The MCS 01 is used to measure current of waveforms 2, 3 and 6.	
6	Wide-band Current Monitor	Model: CM 0103M Peak current: 5 kA; Sensitivity: 0.1 V/A; Frequency: 200 Hz ~ 20 MHz; Max. 0.2 A·s Charge; For measuring W2, W3(1&10 MHz) and W6;	
7	Multi-group Pulse Test System	Model: ETS 160MB-35U The ETS 160MB-35U is used to place all devices and accessories to makes the storage in order; There are two main unit storage tanks and four waveform input modules storage tanks, and each tank having sliding rail, which makes it easy to insert or pull out the modules;	

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