

1. GENERAL

1.1 Scope

This specification defines the performance characteristics of 100W AC adapter which meets Class II, single phase, 100W of constant maximum output power with and without power harmonics requirement, 5V/9V/15V/20V of adaptive output voltage featured by USB-PD, wall-mount form factor with captive Type-C cable.

This specification also defines the world wide national (safety & EMC) requirements and manufacturers' test requirements.

1.2 Design Objective

The design objective is support the latest "USB 3.1 Specification", latest "USB Type-C Specification"(Rev.1.2), the latest "USB Power Delivery Specification"(Rev.3.0*), the latest "USB Security Specification"(Rev.1.0, to be available in 1H/2016), the latest "IEC63002" and "IEC62368-1" fully while optimizing components for cost reduction. It shall have a capability to get USB-PD logo by passing the latest compliance test.

* USB-PD Rev.3.0 shall support USB-PD Rev.2.0 to keep the interoperability as described in the spec.

1.3 Target Products

This AC adapter will be used with existing all Type-C products on field and future products including 3rd party's. A requirement for unit approval is that the adapter successfully pass system integration test for all the Lenovo products at least and some of major OEM products shall be covered as well.

Note: The system integration tests must be successfully completed.

1.4 Type of AC Adapter

Desktop 3PIN modes. WM 2PIN modes

1.5 Role & Responsibility

It is supplier's responsibility to define the regulator technology and components to be used. Lenovo reserves the option to evaluate and / or request a change of circuit design, component selection, mechanical design and manufacturing quality control. Once a power supply design is fixed and approved by Lenovo, any design change, component change, or production process change must be agreed to in writing by Lenovo, prior to its implementation into production.

1.6 Lenovo "Model Name" definition

The "Model Name" is defined here for Lenovo PCG common AC adapters.

All safety certification shall be got by this model name by each supplier.

===== Model Name definition =====

(1)(2) Subsystem Code----- AD= AC Adapter, EB= (External) Battery

(3) Manufacturer Code ----- L= for "Lenovo product"

(4)(5)(6) Output wattage Code Adapter	45W	65W	90W	130W	170W	230W
Code	X45	X65	X90	130	170	230



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- (7) Type Code ----- N = Normal, S = Slim, W = Wall mount, U = Wall mount USB-PD, A = Not applicable ,Y= Desktop USB-PD
 (8) Vender Code ----- D = Delta, L = Liteon, C = Chicony, A = AcBel
 (9) Product category ----- Common = C, IPG = G, TPG = T, NEC = N, Option = P
 (10-1) Geo Code for WM USB-PD -----U=US, K=UK, E=EU, R=Korea, C=China, A=Australia, G=Argentina, B=Brazil, I=India
 (10-2) Input Pin Number for other type adapter ----- 2=2PIN, 3=3PIN
 (11) Appendix Code----- A, B, C.....Y
 ===== End of "Model name definition" =====

1.7 Lenovo Model Name List

Lenovo PN	Description	Model Name	FRU PN	Header code
GX21J75546	Adapter Slim USB-C 100W 3Pin WW 2 cable 90%PCC 160cc Black	ADL100YDC3A	5A11J62090	D1SG

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2. INPUT REQUIREMENTS

2.1 Input Voltage

The adapter must operate at either sinusoidal input voltage range, defined in sections 2.2.1. The adapter shall operate over the entire input voltage range (90-265VAC) or, shall be designed to automatically select appropriate voltage range without manual intervention.

2.1.1 Sinusoidal

	MINIMUM	MAXIMUM	NOMINAL(RATED)
LOW RANGE	90 VAC	137 VAC	100 – 127 VAC
HIGH RANGE	180 VAC	265 VAC	200 – 240 VAC

Note: The terms Nominal and Rated are used interchangeably throughout this spec.

2.1.2 Input Power Harmonic Distortion Content

The harmonic distortion content of the input AC voltage shall not exceed 5%.

2.2 Input Frequency

The input frequency range will be 50+/-3Hz, 60+/-3Hz.

2.3 Switching Frequency

The SW frequency with any load condition shall be more than 28KHz to avoid the audible noise problem. More than 250KHz switching frequency shall NOT be used to avoid malfunction with touch pad. If it is designed as less than 28KHz or more than 250KHz, the approval from Lenovo shall be required with appropriate qualification data.

2.4 Efficiency and Power Consumption at No-load/Light-load

All voltage modes shall meet US DOE/EuP requirement both at Vin: 115V/230V.

5V/3A mode: The adapter efficiency (watts output/watts input) shall be more than DOE: **81.39%** that is the average value of 25%, 50%, 75% and 100% load.

9V/3A mode: The adapter efficiency (watts output/watts input) shall be more than DOE: **86.62%** that is the average value of 25%, 50%, 75% and 100% load.

15V/3A mode: The adapter efficiency (watts output/watts input) shall be more than DOE: 87.73% that is the average value of 25%, 50%, 75% and 100% load.

20V/5A mode: The adapter efficiency (watts output/watts input) shall be more than DOE: 89% that is the average value of 25%, 50%, 75% and 100% load.

The marking shall be put for up-to-date Energy-star (EPA 2.0) and CECP requirement on the main label.

Below table shows power consumption requirement in no load and light load when input power is above or equal to 12W. The efficiency shall be measured after 15 minutes of warm-up.

The light load 0.25W and 0.5W load, test at 5V and 115Vac/230Vac;



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Voltage	Output Load (W)	Input Power (Max)
	0W	0.15W
only support 5V	0.25W	0.5W
only support 5V	0.50 W	1W

2.5 Inrush Current

The adapter inrush current shall be less than the ratings of its critical components (including bulk rectifiers, fuses, and surge limiting device) for all conditions of line voltage of 2.1.1 "Sinusoidal" and during the power line disturbances specified in Section 7.0, "Power line disturbance (PLD) requirements". No component damage. It shall meet fuse and bridge diode I*It.(cold start and hot start)

2.6 Power Line Harmonics requirement and PFC

The input current harmonics requirement shall be met with EN 61000-3-2 for power harmonics models.

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3. OUTPUT REQUIREMENTS

3.1 DC Load Requirements (CV domain)

Before Type-C plug is attached to system, the DC output voltage (Vbus) shall be 0V.

5.0V/9.0V mode shall meet all the requirements with 3A except efficiency.

NOMINAL OUTPUT VOLTAGE	RESISTIVE LOAD (AMPARES)
+ 5.0 V	0.0 to 3.0A
+ 9.0V	0.0 to 3.0A
+ 15.0 V	0.0 to 3.0A
+ 20.0 V	0.0 to 5A

3.2 Connector Pin assignment

CONNECTOR PIN	OUTPUT	REGULATION TOLERANCE (From Nominal)	MAXIMUM CURRENT
Pin A4,A9,B4,B9(VBUS)	+ 5.0V/9.0V/15.0V	+ 5% / -5%	5A
	+ 20.0V	+5%/-5%	
Pin A1,A12,B1,B12(GND)	DC Return		5A
Pin A5(CC)	Connected to USB-PD controller in power brick		200mA
Pin A6, A7(D+/D-)	D+/D- shorted in plug overmold		

3.3 Regulation

Regulation shall be measured at the pins of the mating output connector. A high frequency 0.1 micro-farad capacitor and a 10 micro-farad tantalum capacitor shall be used to terminate each output at the measurement point. The instantaneous output voltages, bandwidth limited to 1MHz, shall remain within the regulation limits of Section 3.2, DC Load Distribution" for any combination of the following:

3.3.1 Voltage

Any change in input voltage within the range specified in 2.1.1, "Sinusoidal".

3.3.2 Frequency

Any change in input frequency within the limits of Section 2.2 "Frequency".

3.3.3 Static Load

Any static load (up to dynamic max current) change on the adapter output within the limits of Section 3.1, DC Load requirements (CV Domain)"

3.3.4 Temperature

Any temperature change within the limits of Section 11.1 "operation" including the effects of altitude specified in Section 11.3 "Altitude".

3.3.5 Warm-up Drift

Any change in output voltage due to warm-up drift.



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3.3.6 Ripple Voltage

3.3.6.1 Definition

The ripple voltage of the outputs shall be measured at the pins of the mating output connector, using a differential technique. Ripple frequencies greater than 1MHz shall be attenuated by the measurement system. Ripple shall be measured under any condition of line voltage specified in Section 2.1.1 "Sinusoidal", frequency specified in 2.2 "Frequency", operating temperature specified in Section 11.1 "Operating", and loading specified in Sections 3.1, "DC Load Requirement (CV domain) and "DC Load Distribute".

A high frequency 0.1 micro-farad capacitor and a 10 micro-farad tantalum capacitor shall be used to terminate each output at the measurement point.

3.3.6.2 Specification

Ripple voltage shall be less than 350mV (peak to peak).(temperature at 25degC)

3.3.7 No Load Operation

The adapter shall be capable of operating at no load and the output voltage shall remain within the regulation limits and ripple voltage. The adapter shall not shut down, cause system error, and allow the system battery to charge properly when its load changes from no load to maximum load. The output shall not become unstable when the adapter is subjected to this condition. This simulates a user connecting the adapter to the AC outlet and then connecting it to a system that is operating normally, or charging the system battery.

The internal power loss at no load operation shall be less than 0.15W at any input voltage.

3.4 Output Transient Load Requirements

3.4.1 Dynamic Load

Test Items	Output voltage	Input voltage	Slew-rate	Test load	Lenovo Spec
Dynamic Load	20V	100Vac / 240Vac	2.5A/us	On/off= 4ms/6ms On/off=50ms/50ms Dynamic-1: 0.00A ~ 5A Dynamic-2: 0.20A ~ 1.50A Dynamic-3: 1.00A ~ 3A Dynamic-3: 1.00A ~ 5A	18.0V~22.0V(+/-10%)
Dynamic Load (Peak power)	20V	90Vac-99Vac 241Vac-265Vac	2.5A/us	On/off=5m/1000ms 1.5* Rate power	18.0V~22.0V(+/-10%)
Dynamic Load (Peak power)	20V	90Vac-99Vac	Dynamic Load (Peak power)	Repeated mode On/off=2s/ 8s 120W→100W Repeated. Non-Repeated mode On =4s 130W Not be repeated.	18.0V~22.0V(+/-10%)
Dynamic Load	15V	100Vac / 240Vac	2.5A/us	0%~90% & 10%~100% On/Off=4ms/6ms, 50ms/50ms(1Hz~5kHz)	13.5V~16.5V(+/-10%)
Dynamic Load (Peak power)	15V	90Vac-99Vac 241Vac-265Vac	2.5A/us	On/off=1m/999ms 45W-68W	13.5V~16.5V(+/-10%)
Dynamic Load (IEC requirement)	9V	100Vac / 240Vac	2.5A/us	160cc:0%~90% & 10%~100% 124cc:10%~50% & 50%~100% On/Off=4ms/6ms, 50ms/50ms(1Hz~5kHz)	8.1V~9.9V
Dynamic Load (IEC requirement)	5V	100Vac / 240Vac	2.5A/us	160cc:0%~90% & 10%~100% 124cc:10%~50% & 50%~100% On/Off=4ms/6ms, 50ms/50ms(1Hz~5kHz)	4.1V~5.5V
Dynamic Load (Peak power)	5V	90Vac-99Vac 241Vac-265Vac	2.5A/us	On/off=1m/999ms 15W-22.5W	4.1V~5.5V



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3.5 Overshoot

Any overshoot at turn on or turn off of AC input shall be **within regulation value**.

3.6 Capacitive Load

The output shall be capable of charging a 100 micro-farad aluminum electrolytic capacitor during turn-on.

3.7 Voltage Transition

Voltage transition shall meet 7.1.4 Positive Voltage Transition and 7.1.5 Negative Voltage Transition Latest USB-PD spec.

3.8 Step Load

9V/15V and 20V mode shall remain in regulation but peak to peak ripple voltage shall be less than 900mV during step load. The step load current is defined the rise and fall between each 1A, such as, between 0 and 1A, 1A and 2A, 2A and 3A, 3A and 4A, 4A and 5A, (20V)/3A (9V and 15V), the rise time of the step load shall be 100uS (when measured from the 10% to 90% points on the waveform). This test is required for CV domain only. The load current is defined from 0A to 5A(20V)/3A(9V/15V).

5V(3A) mode shall remain in 4.4V~5.45V, this shall be measured at VBUS/GND at plug-top and follow below PD spec for step load. The stability of the Source shall be tested in 25% load 9 step increments from minimum load to maximum load and also from maximum load to minimum load.

Need to check for sound level to meet acoustic requirement from inductance parts during this test.

Test Items	Output voltage	Input voltage	Slew-rate	Test load	Lenovo Spec
3.8.1 Step Load	20V	90Vac-265Vac	rise time:100us, 1Hz~1kHz	0A-1A, 1A-2A, 2A-3A, 3A-4A, 4A-5A	18.6V~21.4V
3.8.2 Step Load	15V	90Vac-265Vac	rise time:100us, 1Hz~1kHz	0A-1A, 1A-2A, 2A-3A	13.95V~16.05V
3.8.3 Step Load	9V	90Vac-265Vac	rise time:100us, 1Hz~1kHz	0A-1A, 1A-2A, 2A-3A	8.37V~9.63V
3.8.4 Step Load (USB standard)	5V	90Vac-265Vac	2.5A/us	0%-25%, 25%-50%,50%-75%,75%-100%, 100%-75%,75%-50%,50%-25%,25%-0% (one step period = 100ms)	4.4V~5.45V

The step load is only for 160cc PD 100W, and not for 124cc PD 100W.

3.9 Hot Plugging Requirements

The adapter shall be capable of "hot plugging" into the end product. This requirement is simulated for system capacitor load.

(This kind of inrush current will be made by some capacitors to meet this value)

Connecting the AC adapter to the input AC voltage, then connecting the output connector to the end product. When the adapter is hot plugged to the end product, the adapter output shall be subjected to a transient inrush current. The peak value of the inrush current shall be 28 amperes, with a maximum duration of 40 microseconds. The rise time between the 10% to 90% points on the inrush current waveform shall be 2 microseconds, with the duration between the 15 ampere points on the upward and downward transitions of the inrush current waveforms, being 18 microseconds.



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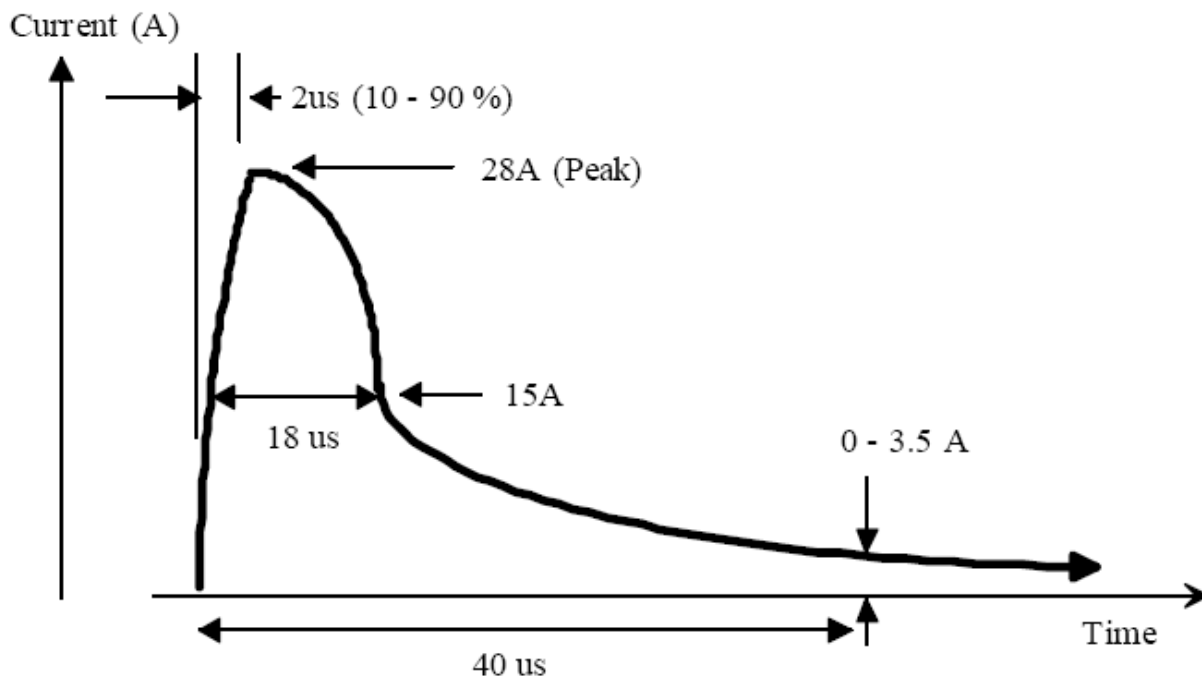
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INRUSH CURRENT WAVEFORM at HOT DC PLUG-IN

This requirement shall apply over the output load range of 0.0 to 3.5 amperes; at any input voltage as specified in section 2.1, "Input Voltage" and, at any ambient temperature as specified 11.1, "Operating". The adapter shall not shut down during this transient load. **The output voltage during this transient load condition shall less than 24V and shall not shut down.**



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4. PROTECTION

4.1 Thermal Protection

The adapter must have thermal protection for abnormal usage for/by parts failure. This protection shall operate before rising to reach to temperature of cover-case's deflection temperature at any case. The adapter shall be shut down and to be latch-off mode with safe.

4.2 Primary (Input)

The input power line must be fused in accordance with the safety requirements of Section 12.0, "Safety". This fuse operation must be confirmed with no any physical damage at its operation.

4.3 Secondary (Output)

4.3.1 Definition

Note: Forms of protection that are not defined in this section, shall not be used in the design without Lenovo approval.

The following definitions apply to Section 4.3, "Secondary".

4.3.1.1 Shutdown

Shutdown is defined as a protection mode whereby the adapter resets automatically to normal operation when the applied fault is removed.

Shutdown DOES NOT require reset of the input AC voltage or any form of intervention (except the removal of the externally applied fault) to reset.

4.3.1.2 Latch-Off

Latch-off is defined as a protection mode whereby removal of the fault AND the recycling (removal and re-application) of AC voltage is required to reset the adapter to its normal operating condition.

4.3.1.3 Bounce Mode

"Bounce" mode is an acceptable form of shutdown. "Bounce" mode is a protection mode whereby the output voltage collapses when a fault is detected. After the initial collapse of the output, the adapter periodically tries to restart. If the fault is still present, the output collapses again. This mode can exist indefinitely and shall not cause damage to, or result in a failure of the adapter to meet its safety, reliability or other requirements of this specification. During bounce mode, the adapters' output voltage shall not exceed the maximum allowed in section 3.2, "DC Load Distribution".

Note: During the bounce mode condition, the average or RMS output power delivered to the fault shall not exceed 5.0 watts. (But shall be design as smaller wattage)


4.3.2 Requirement

The adapter shall protect itself, and shutdown, in the event of an Over Current, Over Voltage or Short Circuit condition, such that, no hazardous condition exists, and shall conform to all Safety Agency requirements, while in the protection mode.

For an over-voltage condition, unit latch-off is acceptable.

4.3.3 Over Current (OC) Protection

When an internal fault occurs, or an external fault is applied to the adapter, such that an overload or short circuit is applied to the output, the adapter shall shut down. Adapter latch off is not allowed. Verification of performance shall be done with a 10 ampere per second ramp current waveform applied to the adapter output. Total constant current range of OCP is less than 7.5A/20V and 4.5A/5V/9V/15V (Make sure it can meet the peak power requirement and no damage on component).

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4.3.4 Over Voltage (OV) Protection

5V mode: If an over-voltage fault occurs on the adapter output, the adapter shall shutdown before the output exceeds **7.5V**. Adapter latch-off is allowed.

9V mode: If an over-voltage fault occurs on the adapter output, the adapter shall shutdown before the output exceeds **11.7V**. Adapter latch-off is allowed.

15V mode: If an over-voltage fault occurs on the adapter output, the adapter shall shutdown before the output exceeds **19.5V**. Adapter latch-off is allowed.

20V mode: If an over-voltage fault occurs on the adapter output, the adapter shall shutdown before the output exceeds **26V**. Adapter latch-off is allowed.

The occurrence of an over-voltage on the output and the subsequent shutdown shall not cause damage to the adapter.

Note: SCR or crowbar circuits which source the holding current from the output voltage rail shall not be used.

4.3.5 Short Circuit

The adapter shall protect itself, and shut down, if a short circuit is placed between DC return and the output. This condition shall cause no damage to the adapter (No electrical over stress). Output latch off is not allowed.

4.3.6 Reset after Shutdown

The adapter shall automatically return to the normal operating mode if the external fault condition is removed (short circuit or external overload) when the AC input, as specified in section 2.1, "Input Voltage" is applied.

4.3.7 Auto Restart

If the output drops due to an AC line transient, brownout, or outage of any duration, the adapter shall automatically reinitiate power on sequencing (if the AC input voltage has returned to the operating range defined in Section 2.1.1, "Sinusoidal").

4.3.8 Connector Pin Short Protection

Because the dust, sweat between connector pins will cause kinds of short in the circuit, AC Adapter must be designed to have protection circuit and corresponding scheme to avoid the connector overheating issue when pin short happened.



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5. POWER SUPPLY SEQUENCING

5.1 AC Power On

When proper AC power is applied, the output shall reach its regulation limits within 3.0 seconds.

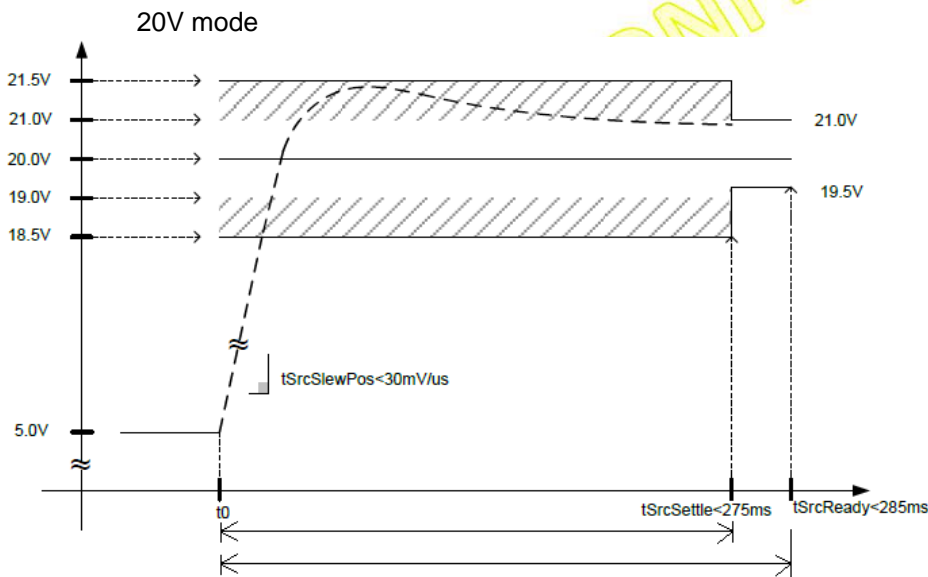
5.2 Output Rise Time

The AC adapter shall transition VBUS from the starting voltage to the higher new voltage in a controlled manner. During the positive transition the AC adapter shall be able to supply the Sink standby power and the transient current to charge the total bulk capacitance on VBUS. The slew rate of the positive transition shall not exceed 30mV/us. The AC adapter output voltage during a positive transition shall settle within the output tolerance range 19.5V-21.0V (20V mode) and 8.55V-9.45V (9V mode)/14.25V-15.75V(15V mode) by Min 230ms/Max 275ms. The AC adapter shall be able to supply the new voltage by 285ms (Max). The positive voltage transition shall remain monotonic while the transitioning voltage is below 18.5V (20V mode), (for 9V/15V, please refer the PD spec) and shall remain within the 18.5V-21.5V (20V mode) (for 9V/15V, please refer the PD spec). The starting time, t_0 , in below figure starts $t_{SrcTransition}$ after the last bit of the EOP of the GoodCRC Message has been received by the AC adapter.

* $t_{SrcTransition}$ is the time the AC adapter waits before transitioning the power supply to ensure that the Sink has sufficient time to prepare. Refer detail in PD spec

* $t_{SrcSettle}$: Settling time from positive transition start (t_0) to when transitioning voltage is within the specified tolerance of the final voltage

Note: 5V mode shall meet $t_{CCDdebounce}$:100~200ms and t_{VbusON} :0~175ms , others shall meet PD standard Spec. Please refer the $t_{CCDdebounce}$ and t_{VbusOn} definition in PD standard Spec.



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6. INPUT AND OUTPUT CONNECTOR

Use USB Type-C connector needs compatible with USB PD female head.

6.1 DC out cable's Normal Mode Impedance Limit

The product shall not have any NORMAL-mode inductance in output line and return line in any secondary circuit. And the impedance of DC wire itself shall be controlled within 10uH at 100 kHz and 1 MHz at each hot line (+20V) and return line (return) DC output cable.

6.2 DC Connector/Cable Mechanical Strength

In line with the mainstream notebook industry standards (H, A), no fire, no overheat. And so on.

6.2.1 Industry test requirements

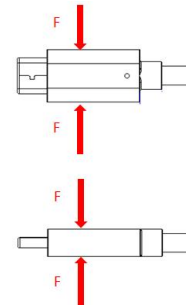
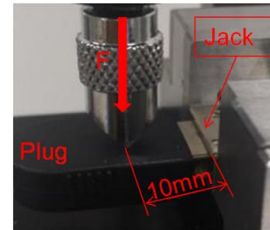
The output dc cable/connector shall withstand industry test requirements to meet with defined criteria.

6.2.2 DC Plug Moment Force test

Criteria: Be functioned and no damage at connector after the force test

Method:

- Fix the jack after plug & jack mating
- Afforded 15kgfcm at the distance of 10mm from the frame of jack (Refer the picture in the left); Diagonal 4 direction
- Hold 10seconds



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6.2.3 Type-C Connector Requirements

Test item	Condition	Requirements
1) Electric strength	DC 500V applied for 1 min between any conductive parts	No brake down
2) Insulation resistance	DC 500V for 1 min between any parts	More than 100M ohm
3) Withdrawal force	DC connector through the mating jack .	Withdrawal force within the range from 6.9 N to 20 N. Insert force Max 20N
4) DC plug molding bending Strength test	Angle: -90 to + 90 Degree W/400g weight by 7000 cycles. Any directions	30% disconnection of any conductor
5) Tensile strength	7 kg for 1 min between accessory and cable	No breakage or damage
6) Salt spray test	Store in the mist of 5% NaCl for 24H. (40 deg C)	No corrosion
7) Endurance test	10000 Cycles/ minimum insert/withdrawal. Repeat test item 1) to 3).	No problem
8) Moisture resistance	Store in 40±2 deg C & 90-95%RH for 48H. Repeat test item 1) to 3).	No problem
9) Heat cycle	5 cycles, -31 degC for 30min and 60 degC for 30min.Repeat test item 1) to 3).	No problem
10) Plug strength test	Insert plug to system and make force (15kg min.) for each (right/left/up/down) direction.	No miss contact and No breakage



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7. POWER LINE DISTURBANCE (PLD) REQUIREMENTS

The adapter shall meet the requirements of the following sections using the sinusoidal input voltage defined in Section 2.2, "Input Voltage".

7.1 Under-voltage/Over-voltage Disturbance

The system unit (including fully charged main battery) with this adapter shall operate error-free during this disturbance of 1, 2 and 3 and no physical damage to this adapter at condition 4.

1. A line input under-voltage of 25% below the nominal for two seconds, repeated ten (10) times with a 10% duty cycle.
2. A line input under-voltage of 35% below the nominal for one-half second, repeated ten (10) times with a 10% duty cycle. The minimum voltage for the low range shall be 68Vac RMS and for the high range shall be 136 Vac RMS instead of applying the 35% to the full range specified in Section 2.1.1, "Sinusoidal".
3. A line input over-voltage of 20% above the nominal for two seconds, repeated ten (10) times with a 10% duty cycle.
4. A line input under-voltage of 100% below the nominal for 20 ms, repeated ten (10) times with a 10% duty cycle.

7.2 Transient Disturbance

The adapter must maintain "error free" regulation and ripple requirements for both minimum and maximum output loading, when subjected to the following disturbances:

1. A 2300 volt (applied common mode) for both models with a surge as defined in ANSI/IEEE C62.41 (91 R1995) and IEC 60060 PT2 (94 AMP196) except for amplitude. The defined test generator has an output impedance of 2 (+/-20%) ohms. The test waveform amplitude is to be set up into an open circuit before applying to the adapter. Three positive and three negative spikes shall be applied at each of 0, 90, 180, and 270 degrees, with at least 3 seconds between each application. This requirement applies to both the 1200 volt test and the 2300 volt test.
2. A 50 nanosecond pulse with amplitude of 1 KV shall be superimposed on the peak of the nominal input voltage and repeated at line frequency for ten (10) minutes. It shall be repeated for both polarities.

Note:

1. Differential mode is defined as between phase and neutral.
2. Common mode is defined as between phase and earth ground.

7.3 Power Outage

The adapter shall experience "no physical damage" due to the following power outages. The percentages below are referenced to the static line voltage before the disturbance occurs, and must cover those ranges defined in Section 2.1, "Input Voltage".

1. 100% outage for 0.1 second, 5 times
2. 80% under-voltage for 0.5 second, 5 times
3. 100% outage for 0.5, 1.5, and 3.3 seconds, 5 times
4. 100% outage for 60 seconds
5. All combinations of:
 - 40%, 50%, 60%, 70%, 80%, 90%, 100% under voltages
 - 25ms, 40ms, 60ms, 90ms, 130ms, 200ms, 280ms, 400ms, 600ms, 900ms, 1.3s, 2s durations
6. Input voltage decrease from nominal to 25% of nominal at a rate 2V per 40 seconds, and then increase back to nominal voltage at the same rate. The adapter may turn off during these tests.



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8. ELECTROMAGNETIC COMPATIBILITY

Tests for conformance to these requirements will be performed with the adapter properly connected to the Lenovo host machine, and with a resistive load box. Connection to the appropriate power line voltage for each test will be made through an ungrounded, unshielded line cord.

The contractor should also be aware that EMI suppression requirements with digital and analog circuits as loads may be greater than when using resistive loads.

The adapter must meet the electromagnetic compatibility requirements below when the adapter is at any load condition, and the input voltage is applied, as defined in section 2.1, "Input Voltage" and a power cord of any length up to 1.0 meters is used.

Note:

- Verification for compliance to these requirements shall be performed with the adapter mounted on a table.
- Compliance shall be verified at a Lenovo test facility.

8.1 FCC Requirements

The adapter shall comply with the United States Federal Communication Commission (FCC) Rules and Regulations, Part 15, Sub-part J, Computing Devices "Class B Limits."

In the label, shall indicate FCC & CANADA Compliance statements reviewed by Lenovo for US/Canada model.

8.2 VCCI Requirements

The power supply with system unit shall conform to "Class II" requirements of VCCI.

8.3 CE Requirements

8.3.1 Emissions (Conducted and Radiated)

The adapter shall conform to the "Class B" requirements of CISPR 22 (EN 55022).

8.4 Compliance Criteria


A statistical assessment will be performed to determine if the production supplies will consistently comply with the EMC requirements. Compliance is achieved when it is shown that with an 80% confidence level, that 80% of the products are **6dB** below the limit using the non-central T distribution for EMI Conductive noise.

Compliance is achieved when it is shown that with an 80% confidence level, that 80% of the products are **6dB** below the limit using the non-central T distribution for EMI **Radiation noise**.

Note:

- These noise measurements are defined as Q-peak hold or Average that is followed with std.
- These noise margin shall be considered for mass-production's variation.

Note2: For 2pin model, measure EMC both without & with connection with GND to secondary return. And check both with "cold start" and "thermal stabilized" conditions

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8.5 EMC Unit Certification

CE (Europe) & FCC(U.S.A) & BSMI (Taiwan) & C-Tick (Australia& New Zealand) & CCC (China) & ICES (Canada) & GOST(Russia) &Serbia/Montenegro&Korea

The adapter shall get unit EMC certification of BSMI, CCC, Korea and mark on label. For BSMI, also needs RPC certification with Model name, For KOREAN EMC certification, Model name and "KOREA Option P/N, see Korean safety requirement item.

The supplier shall obtain unit EMC certifications of CE, FCC, BSMI, CCC, ICES,EAC, Serbia/Montenegro and markings on label for input model. For all certifications, we needs both certificate (include DoC letter) and test reports For Israel, India, these countries also have corresponding compliance requirements. If necessary, the supplier should assist Lenovo to pass the local customs clearance.

8.6 System ISN Requirement

The adapter shall design to meet system ISN requirement and have a PCB pattern preparation for this requirement in 3pin. **This GND pattern's resistor shall be put 1.2k-ohm to prevent system ISN noise.**

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9. Electric and Magnetic Field Emissions.

9.1 DC Return's Connection

This require of 3pin model that the output dc return of the adapter be connected to the mains protective ground (also known as Frame Ground) through 100nF min. film capacitor and also 1M-ohm resistor, these are with parallel. These voltage and wattage rating shall be well considered at Hi-pot testing.

9.2 Electric and Magnetic Field Emissions

When the adapter is connected to the end product, the combination must comply with the electric and magnetic field emissions requirements shown below; when tested according to by the test method contained in document MPR 1990:10.

This requirement applies only when the adapter is used with an end product that contains a visual display unit (any type of screen or display on the end product, regardless of display technology).

The requirement applies with the product in any mode of operation, or loading condition (normal, standby, battery charging, no load, etc.) applied to the AC adapter.

The emissions requirements are summarized in the following tables:

9.2.1 Electric Field Requirements

BAND NUMBER	FREQUENCY (KHz)	MAXIMUM ALLOWED EMISSIONS (VOLTS/METER)
I	0.005 - 2.0	10
II	2.0 -400.0	1

9.2.2 Magnetic Field Requirements

Table showing magnetic field emission requirements (non accredited measurements.)		
BAND NUMBER	FREQUENCY (KHZ)	MAXIMUM ALLOWED EMISSIONS (NANOTESLAS RMS)
I	0.005 - 2.0	200
II	2.0 -400.0	25



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10. CE Requirements

The combined adapter, when connected to the end product, shall comply with the following requirements. The adapter shall bear the appropriate marking indicating certification. The organization responsible for the end product shall file the required documentation to certify that the adapter, when connected with the end product, complies with the requirements described in this section.

10.1 Immunity requirement

(Note that each supplier shall use the published up-to-date each STD level for below test items)

The adapter shall meet the below Immunity requirement based on EN55024 (2010).

1. IEC 61000-4.2 (2008 Ed 2.0) ESD.

And additionally shall meet by $\pm 15\text{KV}$ as Air discharge method.

2. IEC 61000-4.3 (2006+A1:2007 A2:2010 Ed 3.0) RES

3. IEC 61000-4.4 (2011 Ed 3.0) FTB

4. IEC 61000-4.5 (2005 Ed 2.0) Surge immunity

5. IEC 61000-4.6 (2008 Ed 3.0) Conducted Radio Frequency Disturbance

6. IEC 61000-4.8 (2009 Ed 2.0) Mag Field

7. IEC 61000-4.11 (2004 Ed 2.0) PLD

Notes: For Surge immunity IEC 61000-4.5 Requirement

The adapter must maintain "error free" regulation and ripple requirements for both minimum and maximum output loading, when subjected to the following disturbances:

1. 2000Volt (applied differential mode) is required by Brazil model only

Due to Brazil's requirement with a surge as defined in ANSI/IEEE C62.41 (91 R1995) and IEC 60060 PT2 (94 AMP196) except for amplitude. The defined test generator has an output impedance of 2 (+/-20%) ohms. The test waveform amplitude is to be set up into an open circuit before applying to the adapter.

Three positive and three negative spikes shall be applied at each of 0, 90, 180, and 270 degrees, with at least 3 seconds between each application.

2. A 50 nanosecond pulse with amplitude of 1 KV shall be superimposed on the peak of the nominal input voltage and repeated at line frequency for ten (10) minutes. It shall be repeated for both polarities.

Note: 1. Differential mode is defined as between phase and neutral.

2. Common mode is defined as between phase and earth ground.

10.2 Emissions requirement

The adapter shall meet EN55022 (2010: Class B)

Australian standard AS/NZS CISPR 22:2009 Class B (This is needed for RCM , NZ SDOC)

10.3 Power line Harmonics

The adapter shall meet EN61000-3-2 (2006+A1:2009 + A2:2009: Class D)

10.4 Voltage Fluctuation and Flicker

The adapter shall meet EN610003-3 (2008)

10.5 Safety

Compliance with the requirement of IEC 60950 up-to-date Edition. The adapter shall thus comply with the Low Voltage Directive Requirements



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11. ENVIRONMENT

11.1 Operating

Air Temperature	0 to 40* deg C
Relative Humidity	8 to 80 %, none condensing

Note *: See Section 16.2, "Burn In" for burn in test conditions.

11.2 Shipping and Storage

Air Temperature	-31 to 60 deg C
Relative Humidity	8 to 80 %

11.3 Altitude

The adapter must operate to an altitude of 3050 meters (10,000 feet). At the same time adapter need meet CCC 5000 meters request.

11.4 Acoustics and Airflow

11.4.1 Airflow

The adapter shall not contain any cooling devices and shall not have any vented openings. Convection cooling on the outside case shall be assumed.

11.4.2 Acoustic Requirement

The adapter shall not make any acoustical noise. The noise level is less than 25 dB at 50 mm distance at any condition included dynamic and step load in the development stage, and less than 25 dB at 100 mm distance in MP stage . And less than 10dB at 8k/10k/12.5kHz band at 300 mm distance. Measure with well warm up, and with setting adapter both position of "its label down and up".

11.5 Shock and Vibration

11.5.1 Shock Non-operating

The adapter shall be withstand with any safety damage by below drop conditions; Each one test item shall be done by individual unit.

This unit shall withstand 1.0m drop 1 times "repeat" for each all faces (6), all corners (8) total 14 times.

After this test, unit shall be check no failure by below check items Function & Hi-pot and PCB Soldering quality (no crack) of any component and case cover damage. The case cover's crack damage is allowed but shall be checked by "IEC test finger" tool that there is no any hazardous high voltage is touched from outside by this tool

11.5.2 Vibration Non-Operating

A constant 1.0G acceleration shall be applied with a frequency swept from 2Hz to 200Hz and back to 2Hz at 0.3 decades/minute, dwelling at resonant frequencies for 15 minutes at a constant acceleration of 2Gs. Resonant frequencies are defined as frequencies where one to one or higher input/output response is generated. This test shall be conducted on all three axes of the power supply. The minimum test time shall be 30 minutes per axis.



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11.5.3 Operational Vibration

The adapter shall be subjected to a random vibration test at a level of 0.27g's.

The original test will be 30 minutes of random vibration using the power spectral density levels shown in the table below. The values in the table represent a gaussian ergodic process which results in an acceleration level of 0.27 g's rms (root mean square).

Transients will be addressed by allowing the random test input level to vary between 3 sigma and 5sigma, and by the use of transient shock inputs.

Operational Vibration Levels	
Frequency (Hz)	PSD (g**2 per Hz (see Note)
5	0.00002
17	0.0003
45	0.0003
48	0.0003
62	0.0003
65	0.0003
150	0.0003
200	0.00008
500	0.00008

Note: .The term "g**2 per Hz" means "g squared per Hertz".

11.6 Temperature Rise of Adapter's Case Surface

Any point on the surface of the adapter case's rise temperature shall be less than **50 deg C with any input voltage with any load , and shall be less than 45 deg C** with any nominal input line voltage with any load as indicated in section 2.1.1, "Sinusoidal" and an applied at any times.

The measurement shall be done with **on wood** and with no air movement condition. The test shall be done with the Lenovo logo side facing down and also with the adapter logo side facing up.

WM PD 100W adapter shall be less than 40 deg C with 115V/ 230V input line voltage with any load



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12. SAFETY

12.1 Scope

This product shall meet the safety requirements in this section. All agencies shall be applied by "model name", not applied by supplier's own P/N.

12.2 National safety agency approval

This product shall get the national agency approvals required bellows.

All safety must be done by defined "the model on CB/UL/CCC/BSMI, etc report.

12.2.1 Underwriters Laboratory (UL) Listed Component Approval

The contractor shall obtain as "a listed component" according to UL 60950 up-to-date Edition for both rated input voltage ranges prior to acceptance by Lenovo. Products shall bear the "UL Listed Mark"

UL must be done by defined model number.

12.2.2 Canadian Standards Association (CSA) Approval

The contractor shall obtain certification of this product according to CSA C22.2 No. 950, for both rated input voltage ranges prior to acceptance by Lenovo. Products shall bear the CSA Certification Mark. (C-UL is acceptable).

12.2.3 IECCE CB Certificate and Report Approval

The contractor shall obtain a CB certificate and report of this product according to IEC 60950 up-to-date Edition for both rated input voltage ranges of the product and with 40degC ambient & 3050m (10,000 feet) conditions or 5,000 m (if use CCC). The report and certificate must both indicate that testing has been performed in accordance with the deviations listed as Group Differences, as well as any/all individual country deviations, that may exist at the time of certifications. (Included IT power system condition) CB must be done by defined model.-

12.2.4 South Korea Safety (&EMC) Certification Approval (by KETI, etc)

The contractor shall obtain "the report" and "its certification" from an approved South Korean testing laboratory indicating compliance with the "Safety Control Law for Electric Appliances" with both low and high input voltage range. Product labels shall include the South Korean approval marking, approval number, production date, contact address and other information as the standard requires. This certification shall be get approval by Model name, and TBG Korea option PN (inform later)) and Model name and TBG Korea option P/N shall be indicated in certification. This certification required for this model.

12.2.5 South Korea Energy Star (ES)'s MEPS Test Report

The contractor shall obtain "the MEPS Test Report" of from an approved South Korean Lab with applicant company name (Lenovo Korea/Bosung Computer). Base on this report, importer (Lenovo Korea/Bosung Computer) will apply MEPS certification to KEMKO. Put the required statement of that compliance on the label in this model.

12.2.6PSE (DEN-AN) Certification Approval

The contractor shall obtain certification of this product according to DEN-AN (from APR/2001 effective) with 100/200Vac input voltage range. Products shall bear the appropriate certification mark (As "the Importer" shall be listed "Lenovo Japan" on label.) and provide to Lenovo this copy of certification for this model.

12.2.7 Australian/New Zealand Electrical Approval

The contractor shall obtain an Australian permit number for this product, prior to acceptance to Lenovo. The permit, which is to be issued by an authorized Australian test house, shall be obtained to the most recent edition of IEC 950. The product shall bear the permit number.

12.2.8 Australian GEMS

The contractor shall obtain the Australian GEMS and listed on WEB by "Model name" and "Lenovo P/N". Multi-output ac adapter are not required by this GEMS.



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12.2.9 Nordic Countries Approval

The contractor shall obtain product approval from one of the Nordic safety agencies (NEMKO, SEMKO, DEMKO, or SETI (FIMKO)); such that, one agency (N/S/D/F) marks can be placed on the adapter.

12.2.10 CCC (China) Approval

The contractor shall obtain product approval of CCC (Safety & EMI) and with manufacturing factory approval for this model. Included 5,000m altitude & Torrid zone temperature operation conditions. This certification shall be get approval by Model name and TBG China option (inform later) . Model name and TBG China option P/N shall be indicated in certification.

12.2.11 PSB Approval

The contractor shall obtain product approval of PSB (Singapore) based on obtained CB report and put marking.

12.2.12 Norma Oficial Mexicana (NOM) Approval

This product shall comply with the requirements of Mexican standard NOM-001-SCFI-1993 (NOM-I-171), Base on meet this standard and CB report, the supplier shall apply NOM by each supplier and marking NOM mark on label.

12.2.13 Russian/Belarus/Kazakhstan Approval Marking

The contractor shall obtain product approval of EAC based on obtained CB report/ CE Immunity report.

12.2.14 UL-Argentina (IRAM) Approval

This product shall comply with the requirements of UL-Argentina requirement. This unit shall apply UL-Argentina based on UL report by each supplier and shall indicated "UL-Argentina" marking and its "S" marking in parallel. Supplier shall provide the certificate and send 1pc sample to Argentina Lenovo then Lenovo Argentina will go process of transition to Lenovo's own certificate.-

12.2.15 Serbia EMC & Safety Approval

The supplier shall obtain Serbia EMC & Safety and apply these appliance markings on label for 3pin model

12.2.16 Croatia EMC Approval (Not required) =>included by CE EMC

The supplier shall be obtain Croatia EMC and apply its alliance marking on label.

12.2.17 GS Marking for Germany

The supplier shall be obtain GS safety certification based on EN 60950 (ITE product) for GS mark (via Nemko or TUV or VDE) and apply its alliance marking on label.

12.2.18 CECP (China) Approval

The supplier shall be obtain CECP (China) certification based on CECP requirement of China and apply its alliance marking on label.

12.2.19 SASO (Saudi Arabia) Approval

The supplier shall be obtain SASO (Saudi Arabia) certification based on SASO requirement and making required new logo on label

12.2.20 Ukraine Approval

The supplier shall be obtain Ukraine certification based on Ukraine requirement and making new logo stile logo with test house code on label.

12.2.21 Serbia/Montenegro

This product shall comply with Serbia/Montenegro Safety Certification requirement.

12.2.22 NZ SDOC

NZ requirements for Lenovo end system with Telecom function, adapter products need to get SDOC (Supplier Declaration of Conformity) based on AS/NZS60950.1.2003 included Amendments 1 to 3...


Information technology equipment	AS/NZS 60950.1:2003, including Amendments 1 to 3	IEC 60950-1 Ed 2.0 as modified by Annex ZZ of AS/NZS 60950:2003, including Amendments 1 to 3
Power supplies for IT equipment	AS/NZS 60950.1:2003, including Amendments 1 to 3	IEC 60950-1 Ed 2.0 as modified by Annex ZZ of AS/NZS 60950:2003, including Amendments 1 to 3

12.2.23 Israel SII Approval

The supplier shall obtain SII certification for this model.

12.2.24 NRCAN Approval

The supplier shall obtain NRCAN certification by "model name and Lenovo P/N and FRU P/N".

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The supplier must resist on NRCAN WEB by model name by P/N and FRU P/N.

And making is required on the label.

12.2.25 Mexico Power Consumption indication requirement

This product shall be indicated the defined power consumption on main label.

12.2.26 BIS Approval

This product shall have Indian (BIS) and register number on label

12.2.27 Other countries

For South Africa, Nigeria, Kenya, Kuwait, Israel, Cambodia, Moldova, Uzbekistan, Malaysia these countries also have corresponding compliance requirements. If necessary, the supplier should assist Lenovo to pass the local customs clearance.

12.3 End Product Requirements

12.3.1 Leakage Current

The adapter leakage current, when measured per the test configuration in IEC 950, shall not exceed 25 uA with 264Vac @ 50 Hz input for all models. (Y capacitor needs equal or less than 330pF)

12.3.2 Secondary Outputs

All secondary outputs shall be "safety extra low voltage" (SELV), and shall not be capable of providing energy levels in excess of 240VA under normal or overload conditions.

12.3.3 Combustible Materials

Structural materials within the adapter and printed circuit boards must be rated 94V-1 or better. Electrical components need only meet the appropriate test house ignition requirements.

12.3.4 Isolation from Primary Circuits to FG, and to SELV circuits

Primary circuits shall be isolated from both FG (Frame Ground), and SELV circuits, by double insulation construction. If the capacitor is used as isolation, shall be use 2 pcs in series.

And if use the capacitor recognized as "Y1 capacitor", may use as one piece, this capacitor shall be needed Lenovo approval for using also.

12.3.5 Ball Impact Test

In addition to the solid cover area, the plug area will also be tested in accordance with IEC-950 requirements.

12.3.6 Enclosure Openings

Enclosure openings are not permitted, it shall be welded.

12.3.7 Flammability of Enclosure

Enclosure shall meet V-0 flammability requirements as specified in IEC 950 and/or UL94.

12.3.8 EC Directive Conformance Declaration Requirement

Based on the confirmed performances as unit that are required by EC directive, this product shall be done self declaration as unit and marked "CE-Marking" on rating label for input 3 pin model based on the **unit EMI & Noise Immunity compliance report**. These report shall be done by the **test house complied with ISO-25 (Guide), such as, NVLAP or A2LA**.

These all CB report and Unit EMI report and Unit Noise Immunity Reports shall be provided to Lenovo by "PDF" soft files.

12.3.9 ENERGY STAR and CECP Compliance

This Power Adapter shall meet the latest ENERGY STAR (US) and CECP (China Certification Center for Energy Conservation Products) requirements. And the adapter should bear International Efficiency Level markings "VI" and CECP marking.

12.3.10 Smokeless Design

In addition to the failure criteria in IEC-950 Cl. 5.4.9, the equipment also shall not emit visible smoke or an unreasonable amount of smoke odor during any of the abnormal tests described in clause 5.4



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12.4 Environmental Impact

The adapter's all material and in manufacturing process, the Lenovo spec 41A7733 (RoHS) and 41A7731 (Environment) shall be met. In case that some deviation per this specification was found, shall provide that deviation to Lenovo immediately.

12.4.1 Lenovo EPEAT Requirements

All desktop, laptop and computer monitor products provided under this contract are required to have achieved Silver or Gold registration under the Electronic Products Environmental Assessment Tool (EPEAT). The registration criteria and list of registered products are provided at www.epeat.net.

12.4.2 Lenovo PEP Requirements

Supplier is required to provide and input the following information in Lenovo ePEP (Product Environmental Profile) System by IPC 1752

1. The document which Suppliers is committed to meet EPEAT/RoHS requirements: "Commitment letter" (so called "EPEAT/RoHS DoC")

Supplier is responsible for "full" compliance, not "partial" compliance. Any "exclusion" statement is not accepted.

Regarding EPEAT, the following requirements must be met.

Elimination of intentionally added cadmium

Elimination of intentionally added lead in certain applications

Hexavalent chromium

Elimination of intentionally added SCCP14 flame retardants and plasticizers in certain applications

Large plastic parts free of certain flame retardants classified under European Council Directive 67/548/EEC

Batteries free of lead, cadmium, and mercury

Large plastic parts free of PVC

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13. RELIABILITY

13.1 Failure Rate

The failure rate shall be defined at 25 degrees centigrade, ambient temperature, sea level, both 110 and 220 Vac, and 100 percent of output load.

The failure rate shall be maintained throughout the operational life of the adapter as specified in Section 13.2, "Operand Life".

The failure rate shall be less than 0.26% per 1000 hours.

13.2 Calculation Verification

The theoretical failure rate shall be calculated by the contractor at 25 degrees centigrade, at both 110 and 220 volts AC by MIL-HDBK 217 or other method. All other conditions shall be as defined in Section 13.1, "Failure rate". If the calculation shall be made in strict accordance with MIL-HDBK-217E, use an environmental factor of 1 (ground benign). Any deviations to the PI factors or methodology shall be indicated in the calculations and justified with appropriate data.

13.2.1 Empirical Verification

The failure rate specified in Section 13.1, "Failure Rate" shall be verified by empirical data obtained from life testing performed by the contractor. The test conditions shall include, but not be limited to:

1. 90 and 265 volts ac input voltage.
2. 100W output load condition.
3. 40-45 degree C. (or Lenovo approved ambient temperature.)

The contractor shall provide their test conditions and procedures to Lenovo, for approval, prior to the start of the test.

13.3 Operational Life

The adapter shall be designed for a minimum life of 8800POH (Power-On Hours) at 25 deg C ambient and 115/230Vac, 100% full load. This requirement shall be verified by empirical data from the contractor using test conditions and procedures approved by Lenovo.

13.4 AC Cycles

The adapter shall be designed to withstand a minimum of 4200 cycles of any nominal input line voltage without failure rate degradation.



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14. Mechanical Requirement

14.1 Outline Dimension

Nominal/Maximum dimensions are defined as follows;

Dimension	Nominal (mm)	Maximum (mm)
Length		
Width		
Height		

For outside ID, 90W case cover, DC out SR and DC Plug ID, refer to each Dwg.

14.2 Weight

The weight of this AC/DC adapter (including the DC output cable assembly, but excluding the AC power cord), shall not exceed grams.

14.3 Other Accessories

There shall be "Lenovo LOGO", "Rating Label", "Caution Label", "Velcro" and "Bar Code Label" shall be included as part of this AC/DC adapter assembly.

14.4.1 DC Cable Requirement

DC cable length: 180cm+/-5cm. Cable ID shall be defined by Lenovo. Sample is needed for appearance check by Lenovo. DC cable shall meet below impedance/dimension requirements below.

VBUS Impedance	GND Impedance	CC Impedance	Cable OD[mm]	DC plug Height[mm]
74ohm Max	74ohm Max	1924ohm Max	4.0+/-0.2	6.5Max

*Above impedance includes cable impedance and one mating contact resistance.

PIN ASSIGNMENT

AWG WIRE	USB PIN
Vo(RED)	A4,A9,B4,B9
GND(BLACK)(DRAIN+SPIRALS)	A1,A12,B1,B12
CC(BLUE)	A5
D+/D-	A6,A7 SHORTED



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15. AC plug mechanical strength

The Inlet and Lenovo power cord shall be confirmed the contact mechanical strength by the inserting & taking off cycling with kneading method. The diameter of power cord's connector that connects with INLET pin shall be less than 2.025mm in LINE & NEUTRAL connector, and less than 3.00mm in GND connector after this kneading test. This values shall be confirmed by PIN GAGE, its tolerance shall be within 0.025mm.

This kneading test shall be done continuously by any kind of kneading angle conditions until its diameter value of connector will be stabilized value, and before 500 times inserting & taking off cycling, the measured diameter values would be no change, this test shall be stopped by 500 times kneading and shall be confirmed to meet the requirement.

16. Design Verification and Approval

The design of this adapter shall be approved by Lenovo prior to acceptance for production. This approval shall consist of examination and testing of the adapter in the areas of electrical, thermal and mechanical design. Documentation to support this approval such as theory of operation, schematics, bills of material, printed circuit layout drawings, mechanical drawings, component qualification procedures and test data, component part drawings, component source lists, component stress computations and measurements, thermal test procedures, results and limits, design verification test data, failure rate calculations and available life test data must be supplied to Lenovo by the contractor prior to approval. Design verification testing must be performed by the contractor to document the adapter's ability to conform to this specification and indicate any inherent design margins.

17. Lead free Requirement

This product shall be design to meet RoHS, Any Finishes deviation is not allowed for Pb-free parts.



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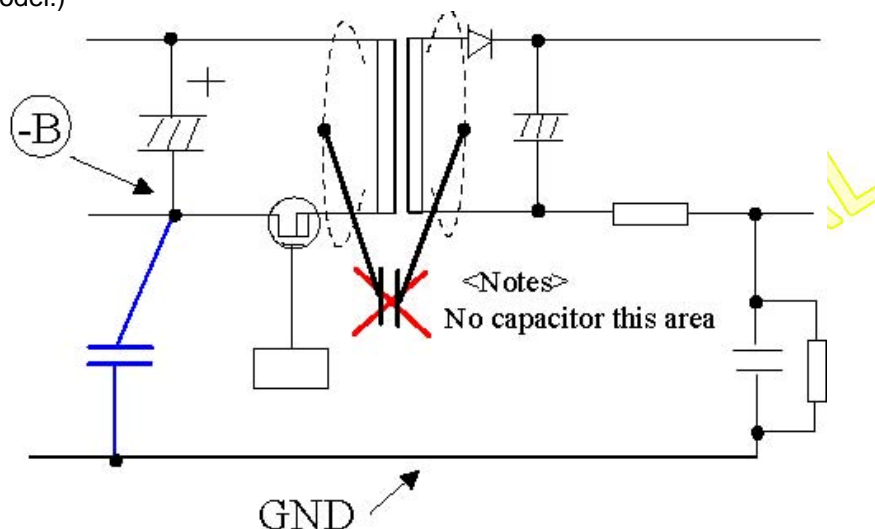
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18. Other Supplement requirements

18.1 Supplement EMC filter capacitor's requirement

The primary & secondary "bridge" capacitor shall not be used in 3pin (GNDed) model.
Instead of this bridge capacitor, the capacitor may be connected between (-B) and GND. (see below figure).
For the input 2pin (non-GND) model, this "Bridge" capacitor may be used.-
3PIN "Y" capacitor shall be equal or less than (equal) 330Pf (Mandatory)

(This "Bridge" capacitor" means that the capacitor that is connected "directly" between primary and secondary in 3pin model, and the "total capacitor" between primary to secondary directly or through conductive parts, such as internal metal shield, in 2pin model.)



Note: Primary-Secondary "Bridge" Capacitor.



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19. PRODUCTION TESTING

19.1 Functional Verification

Production testing must be incorporated by the vendor to verify that all (100%) products shipped to Lenovo under this specification meet the following requirements.

Requirement	Section
Input Voltage	2.1.1, "Sinusoidal"
Output Requirement	3.1, "DC Load Requirement (CV domain)"
Over Current	3.3, "Constant Current (CC) domain"
Regulation	3.5.1, " Voltage ", and 3.5.3, "Static Load"
Ripple	3.5.7, "Ripple Voltage"
Short Circuit	4.3.5, " Short Circuit"
Over voltage	4.3.4, "Over Voltage(OV) Protection"

Conformation to the remainder of the requirements shall be verified in Section 15.0, "DESIGN VERIFICATION AND APPROVAL". All functional tests must be conducted at the input voltage range of Section 2.1.1, "Sinusoidal". Production testing shall also include verification of proper location and polarity of all discrete primaries AC wiring. Production line failure data shall be made available to Lenovo for review and appropriate action. Production test procedures shall be approved by Lenovo prior to implementation.

19.2 Burn In

All products shipped to Lenovo under this specification will be subjected to a functional burn in as described in "Power Supply Quality/Manufacturing Requirements for Lenovo Personal Computer Company". The adapter shall be designed such that no component shall exceed its maximum temperature rating during burn-in at a 40 +/- 5 degrees centigrade ambient. Burn-in failure data shall be made available to Lenovo for review and appropriate action. Alternative burn-in procedures may be acceptable only if evaluated and approved by Lenovo Engineering prior to implementation.

19.3 GND Continuity Test & Hi-pot

100% production testing for hi-pot and GND continuity test shall be performed in accordance with the safety agency requirements of Section 12.0, "SAFETY". The Hi-pot test shall be done with a DC voltage and a current sensitivity setting on the equipment shall be 50 micro amps or Lenovo approved setting value. Performing Hi-Pot marking "H" shall be marked on rating label.

19.4 Production Process Control special requirement

19.4.1 Inlet (AC Socket) soldering Process

Inlet shall be connected with wires to PCB (ALL terminals), cannot use the inlet that is direct soldering to PCB. And use the cramping terminal to connect to PCB and the solder to PCB. And after soldering with terminal to PCB, the terminal pin shall not be cut after soldering to avoid solder crack.

19.4.2 The cut lead's length control Process

The maximum lead length after cutting under PCB shall be controlled by special tool at 100% production, not depend on the worker's skill. This process shall be approved by Lenovo. This maximum lead length shall be defined by the value of some space margin clearance between PCB and internal insulator not to paunch out insulator by long lead after case welding.

19.4.3 The wire terminal that is connected to PCB.

All wires that is connected to PCB shall be terminated by cramp terminal as mechanical secure.

19.4.4 The glue/Vanish quantity & quality control on magnetic parts

The glue quantity and its quality shall be controlled by tools that is able to control and needs approval this process by Lenovo.



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20. Type-C/USB-PD Requirements

20.1 CC pin Requirement

In case that CC pin is shorted with 20V on VBUS pin, there shall be no damage. Test report shall be provided.

10.1 Immunity requirement test report shall cover ESD for CC.

CC pin voltage wave shall be checked with actual system when AC adapter attached to system at AC off condition, Abnormal CC pin voltage is not allowed.

20.2 Discharge Time Requirement

To avoid OVP triggered when voltage switches to lower or Type-C plug is detached, the Vbus voltage shall drop to lower than 6.0V in 50ms, and drop to Vsafe 0V in 100ms after Type-C plug detach event. OVP setting change shall be done after voltage switching to lower. The behavior shall be verified with actual system.

20.3 Control/Data/Extended/Vender-defined Message to be supported

USB-PD spec rev.3.0 shall be supported in this product and below Control message, Data message, Extended message, Vender-defined message(VDM) shall be supported.

USB Power Delivery Packet Format including Control Message Payload

Preamble	SOP* (Start Of Packet)	Message Header (16 bit)	CRC	EOP (End Of Packet)
----------	------------------------	-------------------------	-----	---------------------

Legend:

PHY Layer	Protocol Layer
-----------	----------------

USB Power Delivery Packet Format including Data Message Payload

Preamble	SOP* (Start Of Packet)	Message Header (16 bit)	0..7 Data Object(s)	CRC	EOP (End Of Packet)
----------	------------------------	-------------------------	---------------------	-----	---------------------

Legend:

PHY Layer	Protocol Layer
-----------	----------------

USB Power Delivery Packet Format including an Extended Message Header and Payload

Preamble	SOP* (Start Of Packet)	Message Header (16 bit)	Extended Message Header (16 bit)	Data (0..260 bytes)	CRC	EOP (End Of Packet)
----------	------------------------	-------------------------	----------------------------------	---------------------	-----	---------------------

Legend:

PHY Layer	Protocol Layer
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Vendor Defined Message(VDM)

Header No. of Data Objects = 1-7	VDM Header	0-6 VDOs
--------------------------------------------	-------------------	-----------------

20.3.1 Message Types to be supported

Below table shows which message types shall be supported. FR swap is not required for power brick.

Control Message Types to be supported

Bits 4..0	Message Type	Sent by	Description	Support
0 0000	Reserved	N/A	All values not explicitly defined are Reserved and shall not be used.	
0 0001	GoodCRC	Source, Sink or Cable Plug	See Section 6.3.1.	MUST
0 0010	GotoMin	Source only	See Section 6.3.2.	MUST
0 0011	Accept	Source, Sink or Cable Plug	See Section 6.3.3.	MUST
0 0100	Reject	Source or Sink	See Section 6.3.4.	MUST
0 0101	Ping	Source only	See Section 6.3.5.	MUST
0 0110	PS_RDY	Source or Sink	See Section 6.3.6.	MUST
0 0111	Get_Source_Cap	Sink or DRP	See Section 6.3.7.	NA
0 1000	Get_Sink_Cap	Source or DRP	See Section 6.3.8.	MUST
0 1001	DR_Swap	Source or Sink	See Section 6.3.9	MUST
0 1010	PR_Swap	Source or Sink	See Section 6.3.10	Not Required
0 1011	VCONN_Swap	Source or Sink	See Section 6.3.11	Not Required
0 1100	Wait	Source or Sink	See Section 6.3.12	MUST
0 1101	Soft_Reset	Source or Sink	See Section 6.3.13	MUST
0 1110- 0 1111	Reserved	N/A	All values not explicitly defined are Reserved and shall not be used.	
1 0000	Not_Supported	Source, Sink or Cable Plug	See Section 6.3.14	MUST
1 0001	Get_Source_Cap_Extended	Sink or DRP	See Section 6.3.15	NA
1 0010	Get_Status	Source or Sink	See Section 6.3.16	MUST
1 0011	FR_Swap	Sink1	See Section 6.3.17	NA
1 0100- 1 1111	Reserved	N/A	All values not explicitly defined are Reserved and shall not be used.	

Note 1: In this case the Port is providing **vSafe5V** however it will have Rd asserted rather than Rp and sets the **Port Power Role** field to Sink, until the Fast Role Swap AMS has completed.

Extended Message Types to be supported

Bits 4..0	Type	Control/Data	Sent by	Description	Support
0 0000		Reserved		All values not explicitly defined are Reserved and shall not be used.	
0 0001	Source_Capabilities_Extended	Data	Source or Dual-Role Power	See Section 6.5.1	MUST
0 0010	Status	Data	Source only	See Section 6.5.2	MUST
0 0011	Get_Battery_Cap	Control	Source or Sink	See Section 6.5.3	Not Required
0 0100	Get_Battery_Status	Control	Source or Sink	See Section 6.5.4	Not Required
0 0101	Battery_Capabilities	Data	Source or Sink	See Section 6.5.5	Not Required
0 0110	Get_Manufacturer_Info	Control	Source or Sink	See Section 6.5.6	Not Required
0 0111	Manufacturer_Info	Data	Source, Sink or Cable Plug	See Section 6.5.7	MUST
0 1000	Security_Request	Data	Source or Sink	See Section 6.5.8.1	NA



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0 1001	Security_Response	Data	Source, Sink or Cable Plug	See Section 6.5.8.2	MUST
0 1010	Firmware_Update_Request	Data	Source or Sink	See Section 6.5.9.1	Not Required
0 1011	Firmware_Update_Response	Data	Source, Sink or Cable Plug	See Section 6.5.9.2	Not Required
0 1100 - 1 1111	Reserved			All values not explicitly defined are Reserved and shall not be used.	

Data Message Types to be supported

Bits 4..0	Type	Sent by	Description	Support
0 0000	Reserved	All values not explicitly defined are Reserved and shall not be used.		
0 0001	Source_Capabilities	Source or Dual-Role Power	See Section 6.4.1.2	MUST
0 0010	Request	Sink only	See Section 6.4.2	NA
0 0011	BIST	Tester, Source or Sink	See Section 6.4.3	MUST
0 0100	Sink_Capabilities	Source or Dual-Role Power	See Section 6.4.1.3	NA
0 0101	Battery_Status	Source or Sink	See Section 6.4.5	Not Required
0 0110	Alert	Source or Sink	See Section 6.4.6	Not Required
0 0111 -0 1110	Reserved	All values not explicitly defined are Reserved and shall not be used.		
0 1111	Vendor_Defined	Source, Sink or Cable Plug	See Section 6.4.4	MUST
1 0000-1 1111	Reserved	All values not explicitly defined are Reserved and shall not be used.		

20.3.2 Structured/Unstructured Commands to be supported

Structured VDM Commands to be supported

Command	VDM Header SVID Field	Support
Discover Identity	Shall only use the PD SID .	MUST
Discover SVIDs	Shall only use the PD SID .	MUST
Discover Modes	Valid with any SVID.	MUST
Enter Mode	Valid with any SVID.	MUST
Exit Mode	Valid with any SVID.	MUST
Attention	Valid with any SVID.	MUST

Unstructured VDM for Lenovo SW authentication to be supported

Refer to the latest "Lenovo USB-PD authentication for 45W65W 20160706" in detail.

20.4 Message Flow Chart

Output voltage (Vbus) shall be 0V before a communication with system. When AC adapter plug into system, the Rd will be detected by CC Pin voltage and vSafe5V will be output via VBUS.

Below chart shows the flow chart example with S/W authentication for power negotiation that covers from plug attach to required output voltage/current output. In this case, EC has to power up with VBUS: 5V considering dead battery case. Another implementation would be 9V/15V/20V contract in first power negotiation in the case EC is not powered up with 5V and need 9V/15V/20V.

(This flow chart is just for reference, it does not define all the cases that happen in real user application. It shall not violate the industry PD Specification.)



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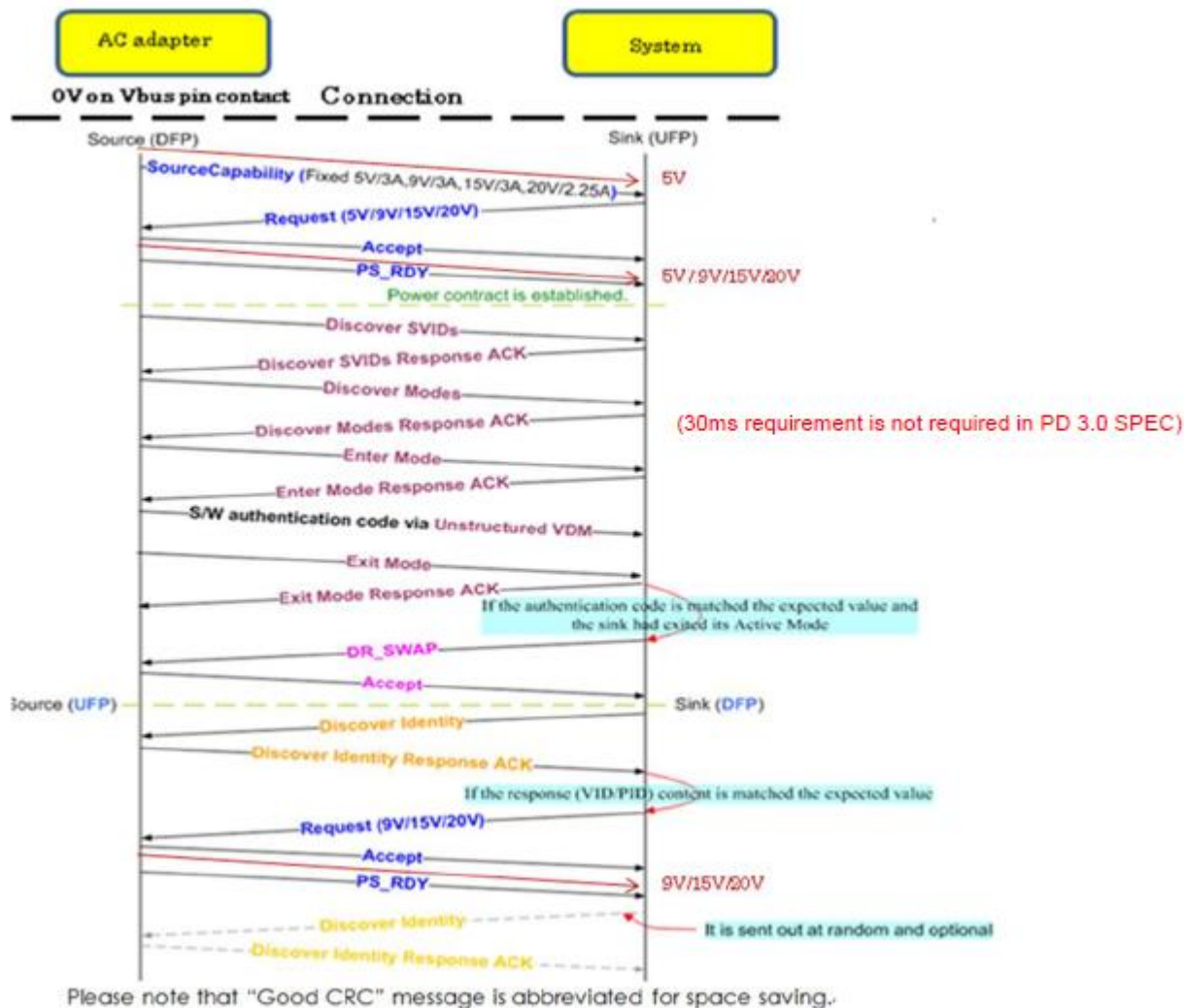
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20.5 Detail Setting of Message

20.5.1 Message Header

Bit(s)	Start of Packet	Field Name	Value
15	SOP*	<i>Extended</i>	0b(Control/Data) or 1b(Extended)
14..12	SOP*	<i>Number of Data Objects</i>	xxxb
11..9	SOP*	<i>MessageID</i>	xxxb
8	SOP only	<i>Port Power Role</i>	1b(DFP)
7..6	SOP*	<i>Specification Revision</i>	10b(Rev.3.0)
5	SOP only	<i>Port Data Role</i>	1b(DFP)
4..0	SOP*	<i>Message Type</i>	xxxxxb

(30ms requirement is not required in PD 3.0 SPEC)

20.5.2 Extended Message Header

Bit(s)	Start of Packet	Field Name	Value
15	SOP*	<i>Chunked</i>	Depends on data size.
14..11	SOP*	<i>Chunk Number</i>	
10	SOP*	<i>Request Chunk</i>	
9	SOP*	<i>Reserved</i>	
8..0	SOP*	<i>Data Size</i>	

20.5.3 Source Capabilities

Below source capability shall be supported as PDO profile.

5V/3A(Peak current 4.5A/1ms)

9V/3A(Peak current 4.5A/1ms)

15V/3A(Peak current 4.5A/1ms)

20V/5A(Peak current: 7.5A/5ms)

PDO[1] ~ 5V

Bit(s)	Description	Value
B31..30	Fixed supply	00b(Fixed Supply)
B29	Dual-Role Power	0b(False)
B28	USB Suspend Supported	0b(False)
B27	Externally Powered	1b(True)
B26	USB Communications Capable	0b(False)
B25	Data Role Swap	1b(True)
B24..22	Reserved – shall be set to zero.	000b
B21..20	Peak Current	01b(150%/1ms)
B19..10	Voltage in 50mV units	0x64(5000mV)
B9..0	Maximum Current in 10mA units	0x12C(3000mA)



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PDO[2] ~ 9V

Bit(s)	Description	Value
B31..30	Fixed supply	00b(Fixed Supply)
B29	Dual-Role Power	0b(False)
B28	USB Suspend Supported	0b(False)
B27	Externally Powered	0b(False)
B26	USB Communications Capable	0b(False)
B25	Data Role Swap	0b(False)
B24..22	Reserved – shall be set to zero.	000b
B21..20	Peak Current	01b(150%/1ms)
B19..10	Voltage in 50mV units	0xB4(9000mV)
B9..0	Maximum Current in 10mA units	0x12C(3000mA)

PDO[3] ~ 15V

Bit(s)	Description	Value
B31..30	Fixed supply	00b(Fixed Supply)
B29	Dual-Role Power	0b(False)
B28	USB Suspend Supported	0b(False)
B27	Externally Powered	0b(False)
B26	USB Communications Capable	0b(False)
B25	Data Role Swap	0b(False)
B24..22	Reserved – shall be set to zero.	000b
B21..20	Peak Current	01b(150%/1ms)
B19..10	Voltage in 50mV units	0x12C(15000mV)
B9..0	Maximum Current in 10mA units	0x12C(3000mA)

PDO[4] ~ 20V

Bit(s)	Description	Value
B31..30	Fixed supply	00b(Fixed Supply)
B29	Dual-Role Power	0b(False)
B28	USB Suspend Supported	0b(False)
B27	Externally Powered	0b(False)
B26	USB Communications Capable	0b(False)
B25	Data Role Swap	0b(False)
B24..22	Reserved – shall be set to zero.	000b
B21..20	Peak Current	01b(150%/5ms)
B19..10	Voltage in 50mV units	0x190(20000mV)
B9..0	Maximum Current in 10mA units	0x1F4 (5000mA)



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20.5.4 VDM(Vender Defined Message)

20.5.4.1 Structured VDM header

4byte

Bit(s)	Field	Description	Value
B31..16	Standard or Vendor ID (SVID)	Unique 16 bit unsigned integer, assigned by the USB-IF	Enter Mode or Discover Modes:17EFh(lenovo USB-IF ID), Discover SVID: 0xFF00(USB-PD Standard ID)
B15	VDM Type	1 = Structured VDM	1b
B14..13	Structured VDM Version	Version Number of the Stuctured VDM (not this specification Version): Version 1.0 = 00b, Version 2.0 = 01b. Values 2-3 are Reserved and shall not be used	01b
B12..11	Reserved	For Commands 0..15 shall be set to 0 and shall be Ignored SVID Specific Commands (16..31) defined by the SVID.	00b
B10..8	Object Position	For the Enter Mode, Exit Mode and Attention Commands: • 000b = Reserved and shall not be used. • 001b..110b = Index into the list of VDOs to identify the desired Mode VDO • 111b = Exit all Active Modes (equivalent of a power on reset). Shall only be used with the Exit Mode Command. Commands 0..3, 7..15: • 000b • 001b..111b = Reserved and shall not be used. SVID Specific Commands (16..31) defined by the SVID.	Enter Mode: 001b Any value from 001b..110b according to Discover Mode which Mode value =1 Discover SVID/Discover Modes: 000b
B7..6	Command Type	00b = Initiator 01b = Responder ACK 10b = Responder NAK 11b = Responder BUSY	00b = Initiator
B5	Reserved	Shall be set to 0 and shall be Ignored	0b
B4..0	Command	0 = Reserved, shall not be used 1 = <i>Discover Identity</i> 2 = <i>Discover SVIDs</i> 3 = <i>Discover Modes</i> 4 = <i>Enter Mode</i> 5 = <i>Exit Mode</i> 6 = <i>Attention</i> 7-15 = Reserved, shall not be used	2= Discover SVID or 3 = Discover Modes or 4 = Enter Mode

20.5.4.2 Unstuctured VDM header & VDO

Below unstructured VDM shall be sent from adapter after Enter Mode-initiator.

4byte

Bit(s)	Signaling	Field Name	Value
B31..16	Vendor ID (VID)	Unique 16-bit unsigned integer. Assigned by the USB-IF to the Vendor.	17EFh(lenovo USB-IF ID)
B15	VDM Type	0 = Unstructured VDM	0b
B14..0	Available for Vendor Use	VDO config version. <= Content of this field is defined by the vendor.	000000000000000b

Below 6 VDO (4byte x 6) shall follow above header portion.

VDO(VDM Object)

VDO	Value
VDO1	Refer the latest FW spec
VDO2	Refer the latest FW spec
VDO3	Refer the latest FW spec
VDO4	Refer the latest FW spec
VDO5	Refer the latest FW spec
VDO6	Refer the latest FW spec



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20.5.5 Discover Identity Command Response

Data role swap shall be supported to become UFP .

Discover Identity Command Response

Header No. of Data Objects = 4-7 ¹	VDM Header	ID Header VDO	Cert Stat VDO	Product VDO	0..3 ² Product Type VDO(s)
--------------------------------------------------	------------	---------------	---------------	-------------	---------------------------------------

Discover Identity Command response in UFP

Bit(s)	Field	Value
Message Header		
15	Reserved	0
14..12	<i>Number of Data Objects</i>	4 (VDM Header + ID Header + Cer Stat VDO + Product VDO)
11..9	<i>MessageID</i>	0..7
8	Port power role	1
7..6	<i>Specification Revision</i>	10b(Rev.3.0)
5..4	Reserved	0
3..0	<i>Message Type</i>	1111b (Vendor Defined Message)
VDM Header		
B31..16	Standard or Vendor ID (SVID)	0xFF00 (USB-PD standard ID)
B15	VDM Type	1 (Structured VDM)
B14..13	Structured VDM Version	01b (Version 2.0)
B12..11	Reserved	00b
B10..8	Object Position	000b
B7..6	Command Type	01b (Responder ACK)
B5	Reserved	0
B4..0	Command	1 (Discover Identity)
ID Header		
B31	Data Capable as USB Host	0 (not data capable as a Host)
B30	Data Capable as a USB Device	0 (not data capable as a Device)
B29..27	Product Type (UFP): 000b – Undefined 001b – PDUSB Hub 010b – PDUSB Peripheral 011b..100b – Reserved , shall not be used. 101b – Alternate Mode Adapter (AMA) 110b..111b – Reserved , shall not be used.	000b (Undefined)
B26	Modal Operation Supported	1 (supports Modes)
B25..23	Product Type (DFP): 000b – Undefined 001b – PDUSB Hub 010b – PDUSB Host 011b – Power Brick 100b – Alternate Mode Controller (AMC) 101b..111b – Reserved , shall not be used.	011b (Power Brick)
B22..16	Reserved. Shall be set to zero.	0
B15..0	16-bit unsigned integer. USB Vendor ID	0x17EF (Lenovo USB-IF VENDOR ID)
Cert Stat VDO		
B31..0	32-bit unsigned integer, XID	XID provided by USB-IF for certification
Product VDO		
B31..0		Refer latest FW Spec



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20.5.6 Source_Capabilities_Extended

Figure 6-23 Source_Capabilities_Extended Message

Extended Header	SCEDB
Data Size = 23	(23-byte Data Block)

Source Capabilities Extended Data Block (SCEDB)

Offset	Field	Size	Type	Description	Value										
0	VID	2	Numeric	Vendor ID (assigned by the USB-IF)	0x17EF										
2	PID	2	Numeric	Product ID (assigned by the manufacturer)											
4	XID	4	Numeric	Value provided by the USB-IF to assign to product	XID provided by USB-IF										
8	FW Version	1	Numeric	Firmware version number	Shall be managed by supplier with version history										
9	HW Version	1	Numeric	Hardware version number	Shall be managed by supplier with version history										
10	Voltage Regulation	1	Bit Field	<table><tr><th>Bit</th><th>Description</th></tr><tr><td>1..0</td><td>00b: 150mA/us Load Step (default) 11b..01b: Reserved and shall not be used</td></tr><tr><td>2</td><td>0b: 25% IoC (default) 1b: 90% IoC</td></tr><tr><td>3..7</td><td>Reserved and shall be set to zero</td></tr></table>	Bit	Description	1..0	00b: 150mA/us Load Step (default) 11b..01b: Reserved and shall not be used	2	0b: 25% IoC (default) 1b: 90% IoC	3..7	Reserved and shall be set to zero	0x04(90% IoC)		
Bit	Description														
1..0	00b: 150mA/us Load Step (default) 11b..01b: Reserved and shall not be used														
2	0b: 25% IoC (default) 1b: 90% IoC														
3..7	Reserved and shall be set to zero														
11	Holdup Time	1	Numeric	Output will stay with regulated limits for this number of milliseconds after removal of the AC from the input. 0x00 = feature not supported Note: a value of 3ms should be used	0x00										
12	Compliance	1	Bit Field	<table><tr><th>Bit</th><th>Description</th></tr><tr><td>0</td><td>LPS compliant when set</td></tr><tr><td>1</td><td>PS1 compliant when set</td></tr><tr><td>2</td><td>PS2 compliant when set</td></tr><tr><td>3..7</td><td>Reserved and shall be set to zero</td></tr></table>	Bit	Description	0	LPS compliant when set	1	PS1 compliant when set	2	PS2 compliant when set	3..7	Reserved and shall be set to zero	0x00
Bit	Description														
0	LPS compliant when set														
1	PS1 compliant when set														
2	PS2 compliant when set														
3..7	Reserved and shall be set to zero														
13	Touch Current	1	Bit Field	<table><tr><th>Bit</th><th>Description</th></tr><tr><td>0</td><td>Low touch Current EPS when set</td></tr><tr><td>1</td><td>Ground pin supported when set</td></tr><tr><td>2</td><td>Ground pin intended for protective earth when set</td></tr><tr><td>3..7</td><td>Reserved and shall be set to zero</td></tr></table>	Bit	Description	0	Low touch Current EPS when set	1	Ground pin supported when set	2	Ground pin intended for protective earth when set	3..7	Reserved and shall be set to zero	0x00(2pin only)
Bit	Description														
0	Low touch Current EPS when set														
1	Ground pin supported when set														
2	Ground pin intended for protective earth when set														
3..7	Reserved and shall be set to zero														
14	Peak Current1	2	Bit field	<table><tr><th>Bit</th><th>Description</th></tr><tr><td>0..4</td><td>Percent overload in 10% increments Values higher than 25 (11001b) are clipped to 250%.</td></tr><tr><td>5..10</td><td>Overload period in 20ms</td></tr><tr><td>11..14</td><td>Duty cycle in 5% increments</td></tr><tr><td>15</td><td>VBUS Voltage droop</td></tr></table>	Bit	Description	0..4	Percent overload in 10% increments Values higher than 25 (11001b) are clipped to 250%.	5..10	Overload period in 20ms	11..14	Duty cycle in 5% increments	15	VBUS Voltage droop	0x0000(Not in Use)
Bit	Description														
0..4	Percent overload in 10% increments Values higher than 25 (11001b) are clipped to 250%.														
5..10	Overload period in 20ms														
11..14	Duty cycle in 5% increments														
15	VBUS Voltage droop														
16	Peak Current2	2	Bit field	<table><tr><th>Bit</th><th>Description</th></tr><tr><td>0..4</td><td>Percent overload in 10% increments Values higher than 25 (11001b) are clipped to 250%.</td></tr><tr><td>5..10</td><td>Overload period in 20ms</td></tr><tr><td>11..14</td><td>Duty cycle in 5% increments</td></tr><tr><td>15</td><td>VBUS Voltage droop</td></tr></table>	Bit	Description	0..4	Percent overload in 10% increments Values higher than 25 (11001b) are clipped to 250%.	5..10	Overload period in 20ms	11..14	Duty cycle in 5% increments	15	VBUS Voltage droop	0x0000(Not in Use)
Bit	Description														
0..4	Percent overload in 10% increments Values higher than 25 (11001b) are clipped to 250%.														
5..10	Overload period in 20ms														
11..14	Duty cycle in 5% increments														
15	VBUS Voltage droop														
18	Peak Current3	2	Bit field	<table><tr><th>Bit</th><th>Description</th></tr><tr><td>0..4</td><td>Percent overload in 10% increments Values higher than 25 (11001b) are clipped to 250%.</td></tr><tr><td>5..10</td><td>Overload period in 20ms</td></tr><tr><td>11..14</td><td>Duty cycle in 5% increments</td></tr><tr><td>15</td><td>VBUS Voltage droop</td></tr></table>	Bit	Description	0..4	Percent overload in 10% increments Values higher than 25 (11001b) are clipped to 250%.	5..10	Overload period in 20ms	11..14	Duty cycle in 5% increments	15	VBUS Voltage droop	0x0000(Not in Use)
Bit	Description														
0..4	Percent overload in 10% increments Values higher than 25 (11001b) are clipped to 250%.														
5..10	Overload period in 20ms														
11..14	Duty cycle in 5% increments														
15	VBUS Voltage droop														



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Offset	Field	Size	Type	Description	Value										
20	Touch Temp	1	Value	Temperature conforms to: 0 = [IEC 60950-1] (default) 1 = [IEC 62368-1] TS1 2 = [IEC 62368-1] TS2 Note: All other values Reserved	0x00(IEC60950-1 only)										
21	Source Inputs	1	Bit field	<table><tr><th>Bit</th><th>Description</th></tr><tr><td>0</td><td>0b: No external supply 1b: External supply present</td></tr><tr><td>1</td><td>If bit 0 is set: 0b: External supply is constrained 1b: External supply is unconstrained If bit 0 is not set Reserved and shall be set to zero</td></tr><tr><td>2</td><td>0b: No internal Battery 1b: Internal Battery present</td></tr><tr><td>3..7</td><td>Reserved and shall be set to zero</td></tr></table>	Bit	Description	0	0b: No external supply 1b: External supply present	1	If bit 0 is set: 0b: External supply is constrained 1b: External supply is unconstrained If bit 0 is not set Reserved and shall be set to zero	2	0b: No internal Battery 1b: Internal Battery present	3..7	Reserved and shall be set to zero	0x03(Not run down over time with external power supply)
Bit	Description														
0	0b: No external supply 1b: External supply present														
1	If bit 0 is set: 0b: External supply is constrained 1b: External supply is unconstrained If bit 0 is not set Reserved and shall be set to zero														
2	0b: No internal Battery 1b: Internal Battery present														
3..7	Reserved and shall be set to zero														
22	Batteries	1	Byte	Upper Nibble = Number of Hot Swappable Batteries (0..4) Lower Nibble = Number of Fixed Batteries (0..4)	0x00(No battery)										

20.5.7 Manufacturer Info

Offset (Byte)	Field	Size	Value	Description	Values in FW
0	VID	2	Numeric	Vendor ID (assigned by the USB-IF)	0x17EF
2	PID	2	Numeric	Product ID (assigned by the manufacturer)	TBD
4	Manufacturer String	0..22	String	Vendor defined byte array If the Manufacturer Info Target field or Manufacturer Info Ref field in the Get_Manufacturer_Info Message is unrecognized return zero bytes.	Notes: Both 2pin and 3pin models use 2pin model name as Manufacturer String TBD

20.5.8 Status Data Block (SDB)

Offset (Byte)	Field	Size	Value	Description	Values in FW		
0	Internal Temp	1	Numeric	Source or Sink's internal temperature in degrees centigrade. 0 = feature not supported 1 = temperature is less than 2°C. 2-255 = temperature in °C.	0x00		
1	Present Input	1	Bit field	B0	Reserved and shall be set to zero	0b	0x06
				B1	External Power when set	1b	
				B2	External Power AC/DC (valid when Bit 1 set) 0: DC 1: AC	1b	
				B3	Internal Power from Battery when set	0b	
				B4	Internal Power from non-Battery power source when set	0b	
				B7-B5	Reserved and shall be set to zero	0b	
2	Present Battery Input	1	Bit field	When Present Input field bit 3 set shall contain the bit corresponding to the Battery or Batteries providing power: Upper nibble = Hot Swappable Battery (b7..4) Lower nibble = Fixed Battery (b3..0) When Present Source Input field bit 3 is not set this field is Reserved and shall be set to zero.	0x00		



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21. OTHERS

21.1 RoHS Requirement

This product shall be design to meet RoHS Lenovo requirement that is defined Lenovo STD P/N 41A7733 (RoHS) . Any Finishes deviation is not allowed for RoHS parts.

21.2 Wave solders Quality control Requirement

The wave solder quality control for RoHS shall be done with care for "Winkle Line" that is impact solder strength.

21.3 PCB type Requirement

Single sided PCB can be used in this AC adapter.

21.4 Voltage Rating of Primary Bulk Capacitor

The voltage Rating of Primary Bulk Capacitor shall be equal and more than 420Vdc shall be used in 3pin model.

21.5 MLCC SMD requirement

The MLCC SMD part's layout must be more than 5.5mm from PCB edge that area is "manual bending cutting after soldering or need Lenovo approval with conditions of manufacturing manual cutting process Control method. (None manual bending cutting area's MLCC is not applied for this requirement.)

21.6 Common Mode Noise Standard

160cc PD 100W need meet Lenovo LBU and TBU Adapter common mode noise standard.

WM 124cc PD 100W need meet Lenovo LBU Adapter common mode noise standard.

LBU COMMON MODE NOISE (CMN) REQUIREMENT

Test Method : Meet china " Information technology—General specification for switching power adapter"

2PIN Adapter :90KHZ~400KHZ <200mV;

3PIN Adapter: FG GND,90KHZ~400KHZ <200mV; FG Floating ,90KHZ~119KHZ < 2V,119KHZ~400KHZ <200mV

TBU COMMON MODE NOISE (CMN) REQUIREMENT

AC adapter CMN(Common Mode Noise) level shall be equal or less than 0dBm in the range from 100kHz to 500kHz regardless of variations in product /environment temperature / cold and hot start / AC input and DC load condition .

Both 2pin and 3pin models are required to test. (3pin model should be tested by Connecting GND mode and Floating GND mode) .This test must be considered all the factors which impact the CMN level such as the placement of the AC adapter brick and the distance from GND plate and so on. The test site for CMN measurement must be certified by Lenovo before used as a formal test site.

Note: This spec does not support the frequency range of N-Trig active pen and MasTouch module.



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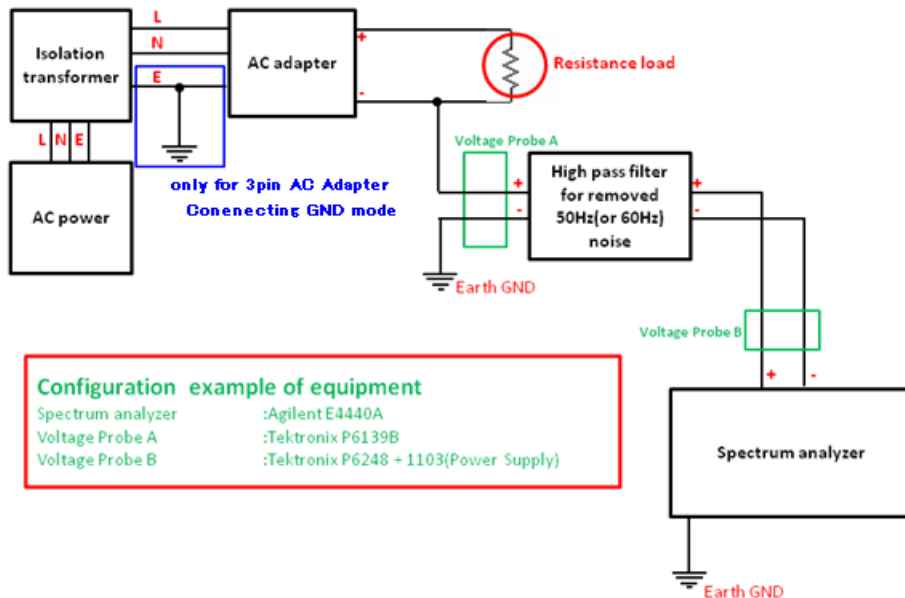
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<Test Condition>

Input Voltage: 100VAC/120VAC/240VAC

Load Power: Refer to Table.1

EUT settings:

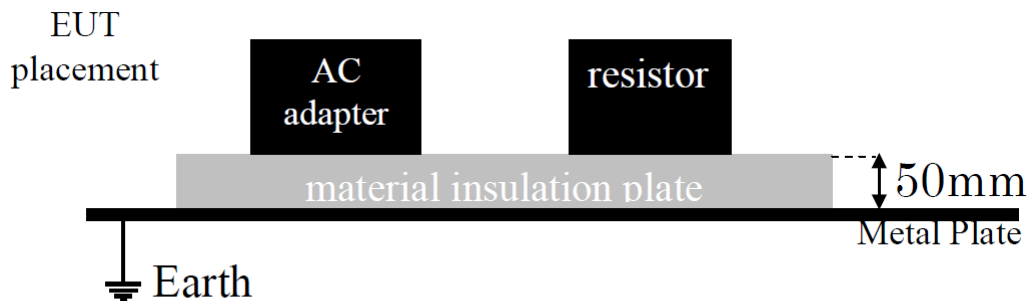
- Distance from metal plate (connected to earth GND):
0mm or more than 50mm with insulation material which is the worse condition?
- AC brick alignment: Test in the worst condition placement
- Cabling: AC cord (keep it straight), DC cord (keep it winded)

Spectrum analyzer settings:

- Resolution bandwidth: 3 kHz
- Measurement time: Max Hold 1minute
- Coupling mode: DC
- Measurement frequency range: 50 kHz to 550 kHz
- Probe A: Tektronix P6139B

Criteria:

Common mode noise level $\leq 0\text{dBm}$ (From 100 kHz to 500kHz)



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Table.1 Load Power points for each mode

PD AC adapter output mode	DC Loading point(W)
5V	0.75W/2.5W/5W/7.5W/10W/12.5W/15W
9V	1.35W/4.5W/9W/13.5W/18W/22.5W/27W
15V	2.25W/7.5W/15W/22.5W/30W/37.5/45W
20V	3W/10W/20W/30W/40W/45W/50W/55W/60W/65W.....

21.7 PPS

Adapter has PPS 5V~11V/3A and 5V~21V/3A

21.8 Tracking test /Glow-wire flammability test for Japan model

(If this adapter is apply PSE by 別表第十二, this test is not required to do)

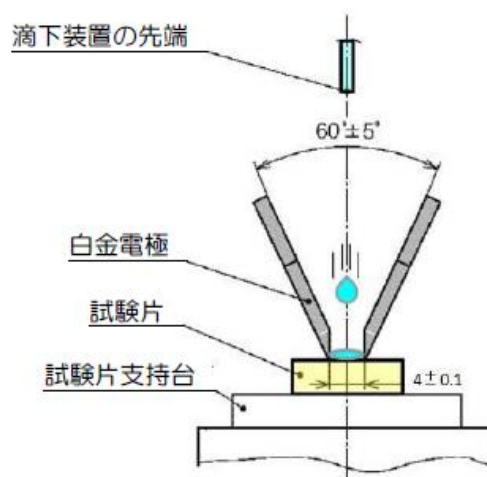
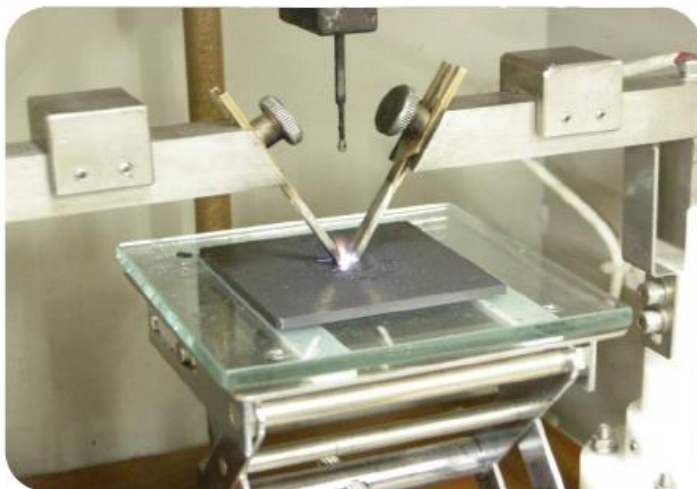
Japan model (Direct plug in AC adapter) must meet requirement of the tracking test and Glow-wire flammability test which is defined by JIS C 2134 and JIS C 60695-2-11, JIS C 60695-2-12.

Tracking test (JIS C 2134):

Condition: PTI: 100V/50drops

Criteria: No tracking destruction and persistent inflammation happen within at least 25s

*Tracking destruction: Over current relay works at the condition of more than 0.5A current during more than 2 seconds



Glow-wire flammability test (JIS C 60695-2-11, JIS C 60695-2-12.):

Condition: Glow-wire at 750 degree / 30 seconds

Criteria: No inflammation or the test sample is not completely burn out and the fire goes out within 30 seconds after removal the glow-wire



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DESCRIPTION :

電氣規格 (Electrical Specification)

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MODEL NO. :

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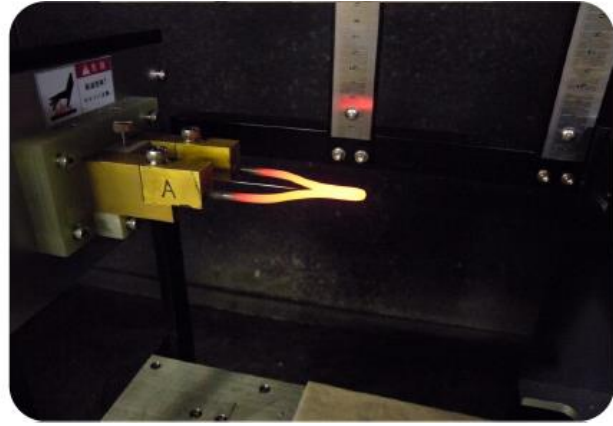
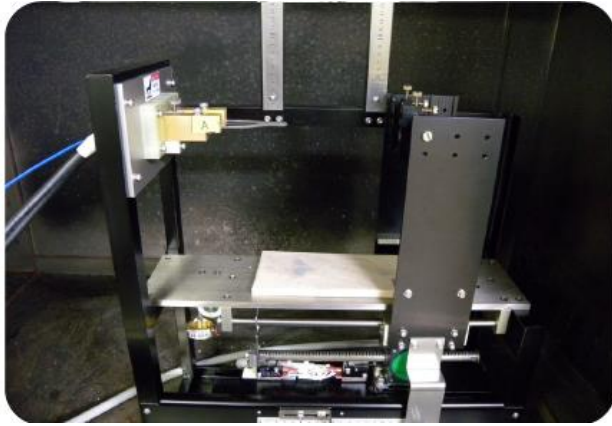
Date	Drawn	Design (EE)	Design (ME)
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21.9 DC Plug Output Test

Operating1:

Temperature: 25°C

Input Voltage: 220Vac/23.5Hz

Load: no load 48Hrs

DC ON/OFF: 3S on/10S off/3S on Cycle Times: 100 times

Result: output voltage normal

Operating2:

Temperature: 0°C

Input Voltage: 264

Load: no load

Result: output voltage normal

22. Product Application: Notebook



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