

GW INSTEK Test & Measurement Seminar – 2017



GW Instek Seminar

- EMC Test
- True waveforms by Signal Sources
- Accurate Measurements by DSO
- Electrical Safety Testing
- **Power Supply Test Solutions**

GW Instek

Power Supply Application Workshop

Presented by
Wayne Wang

GW INSTEK

Made to Measure

固緯電子實業股份有限公司

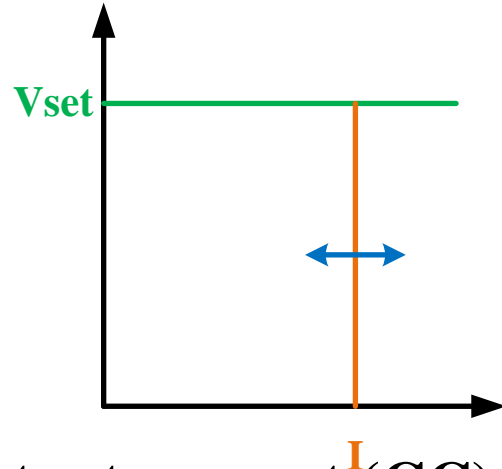
Agenda

- **Illustration of specifications & functions**
 - Slew rate adjustment
 - Test script
 - Multi-range
- **Case study & Applications**
- **Applications for Linear power supplies and Switching Power Supplies.**
- **How to select cheaper power supplies**

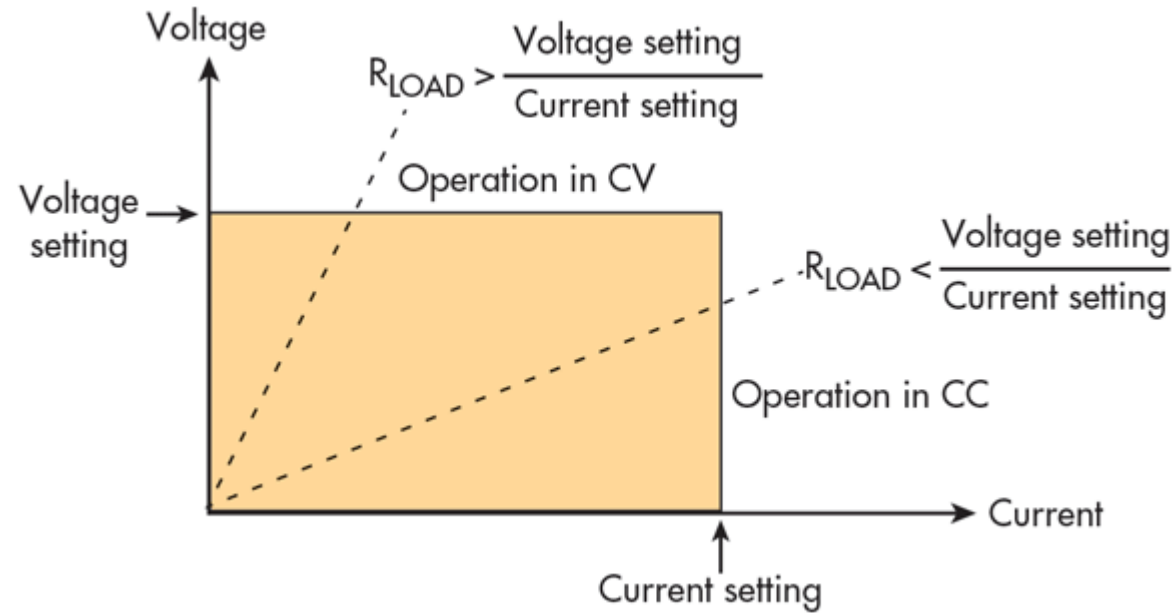
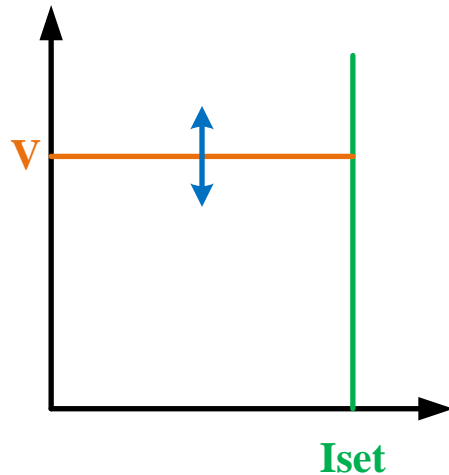
Illustration of specifications & functions

DC Power Supply Output Modes

Constant voltage (CV) mode

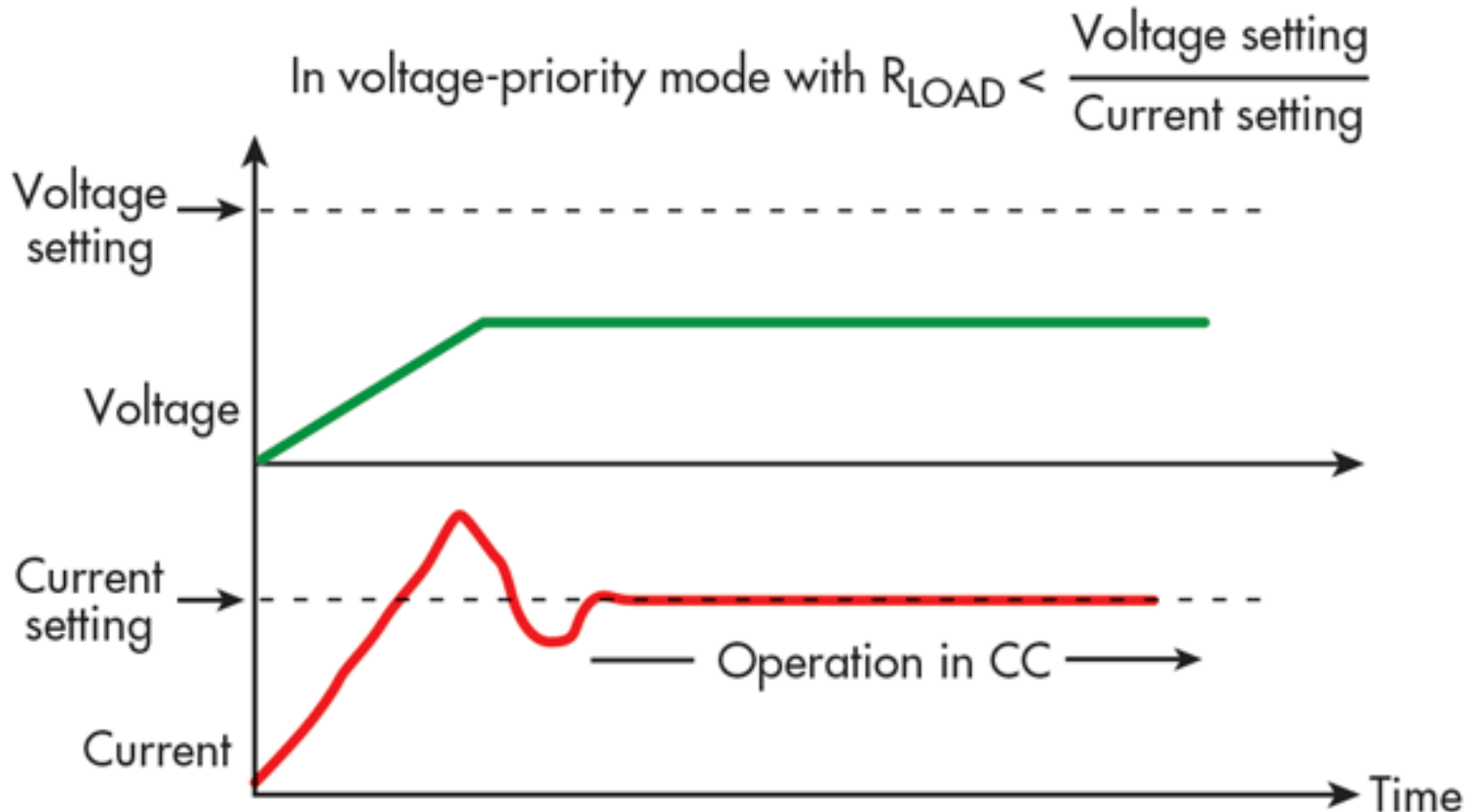


Constant current (CC) mode



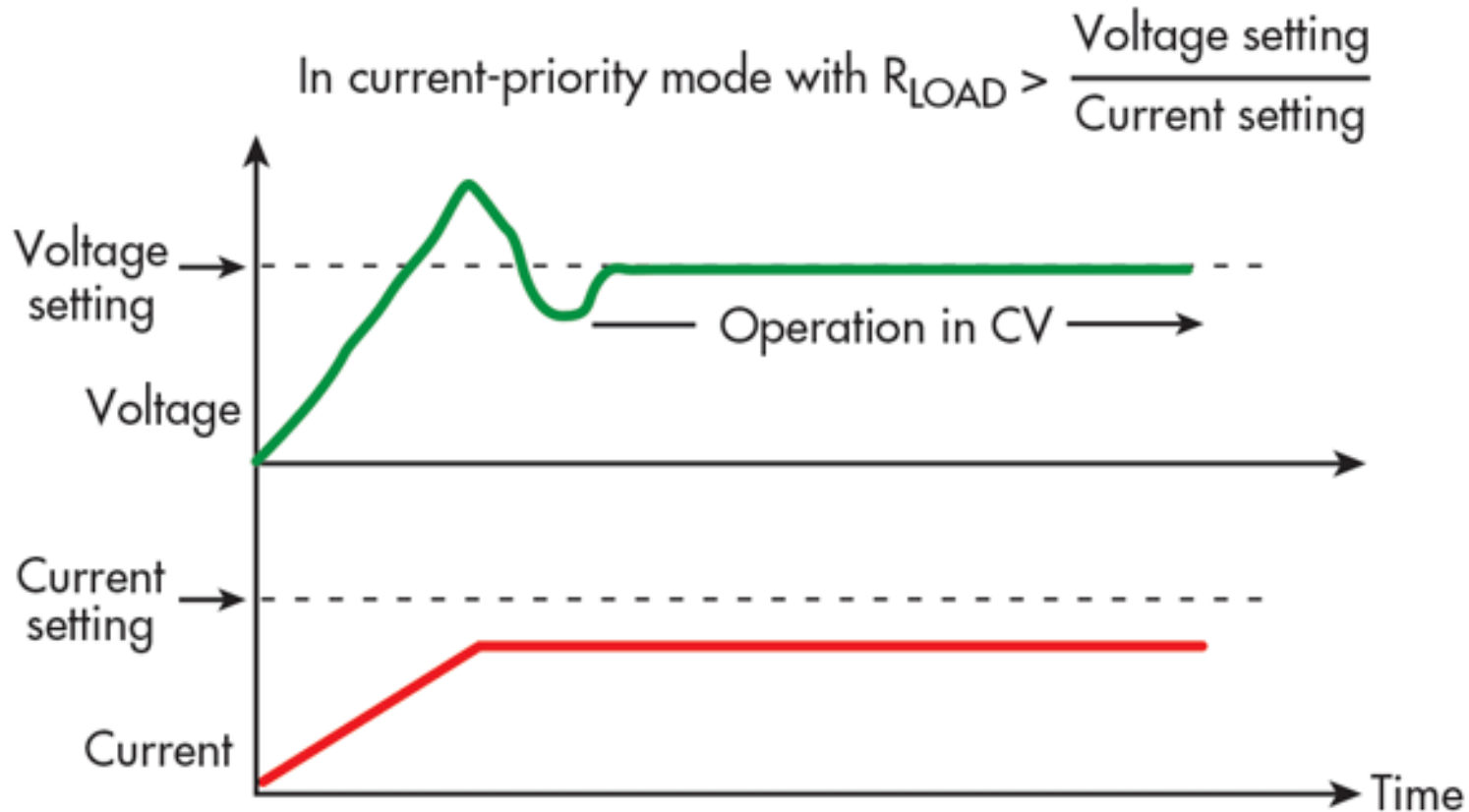
DC Power Supply Output Modes

Constant voltage (CV) priority mode



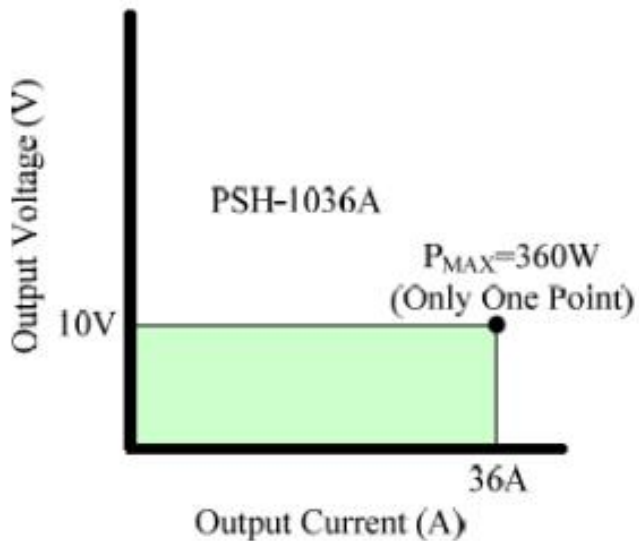
DC Power Supply Output Modes

Constant current (CC) priority mode

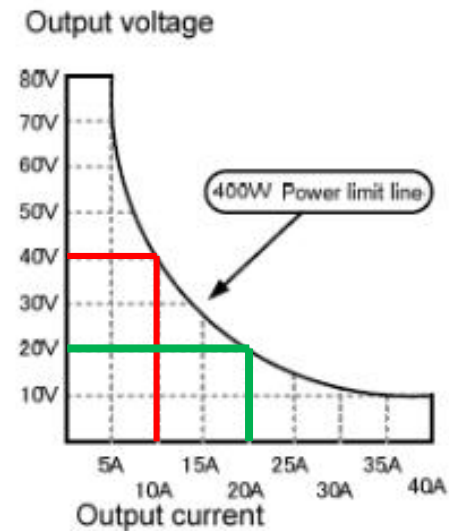


Output Characteristics

Multi-range or Auto Ranging



The operation area of a Conventional Power Supply.



The operation area of a Multi-Range Power Supply for PSB-2000 Series

Remote Sense

Local sensing

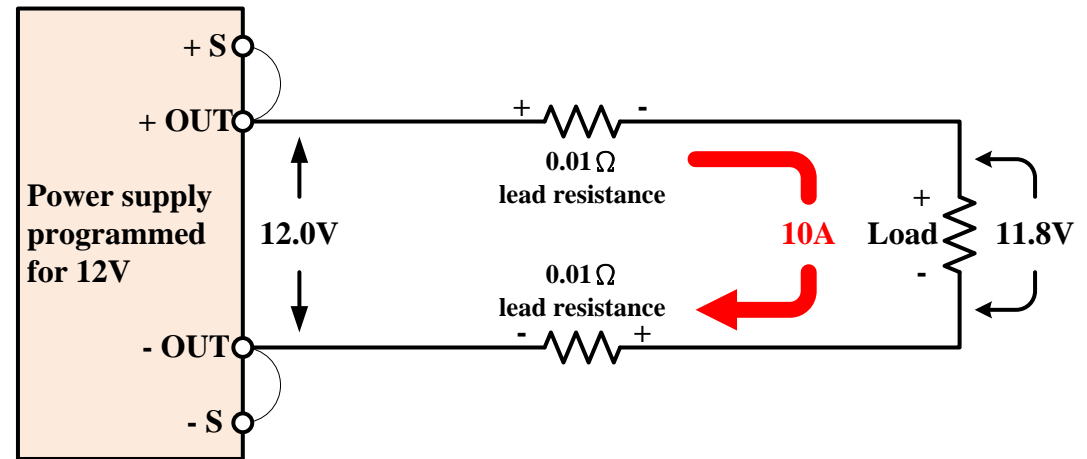
Lead resistance can cause a significant voltage drop between the output of the power supply and the load

AWG wire size Resistance in m Ω /ft (at 20°C)

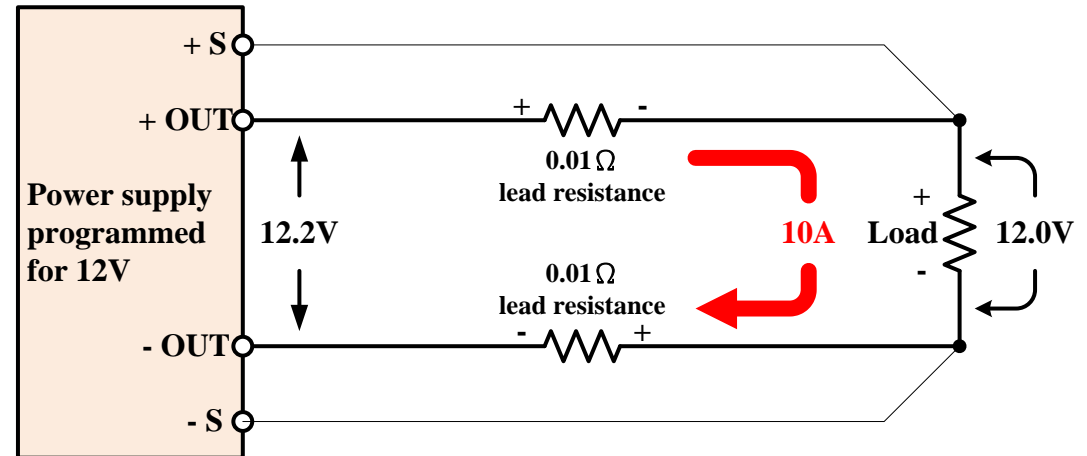
22	16.1
20	10.2
18	6.39
16	4.02
14	2.53
12	1.59
10	0.999

Remote sensing

The sense leads measure the voltage at the load and adjust the power supply output to compensate for voltage drops in the leads



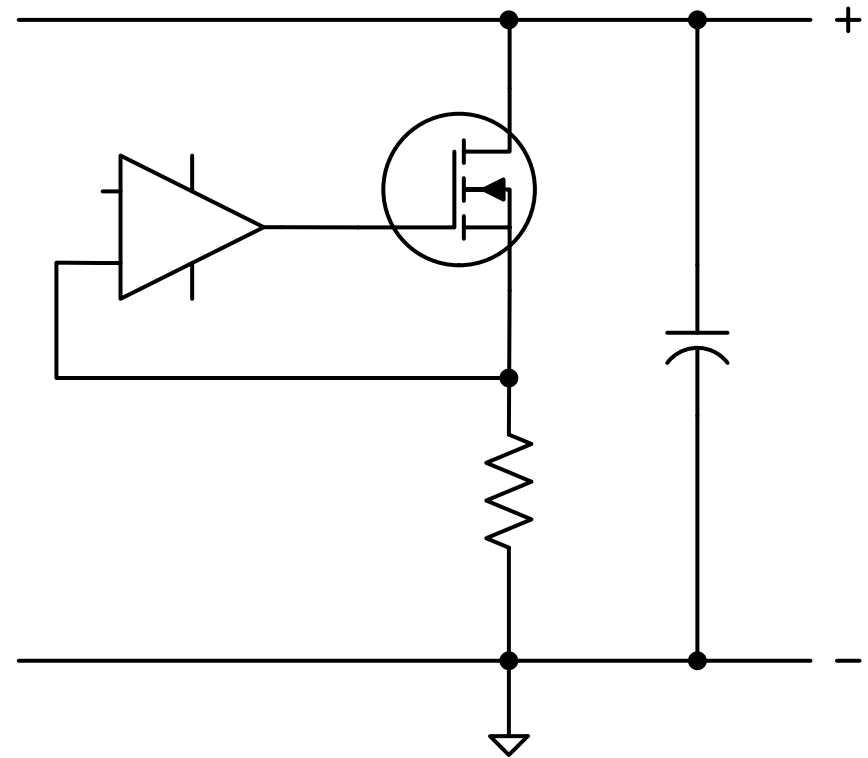
+ OUT and - OUT load leads are 10 feet. 10AWG each



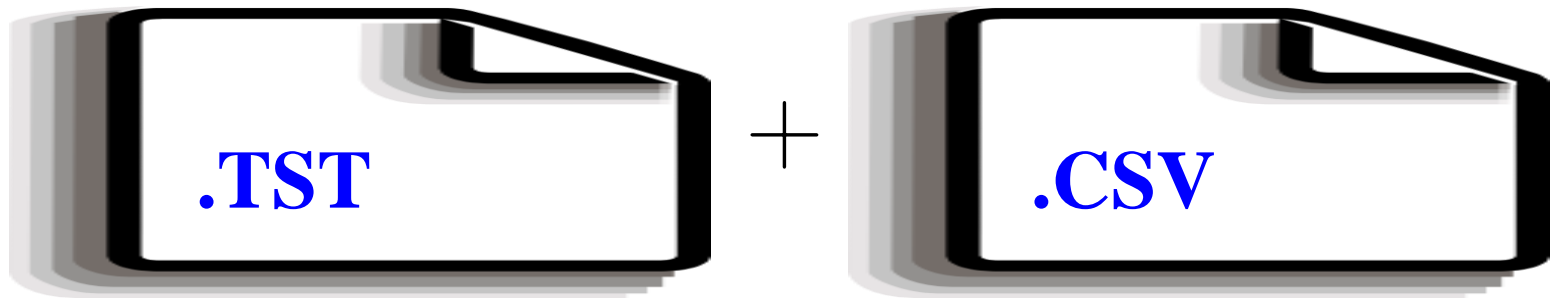
+ OUT and - OUT load leads are 10 feet. 10AWG each

Unique Feature: Bleeder Circuit

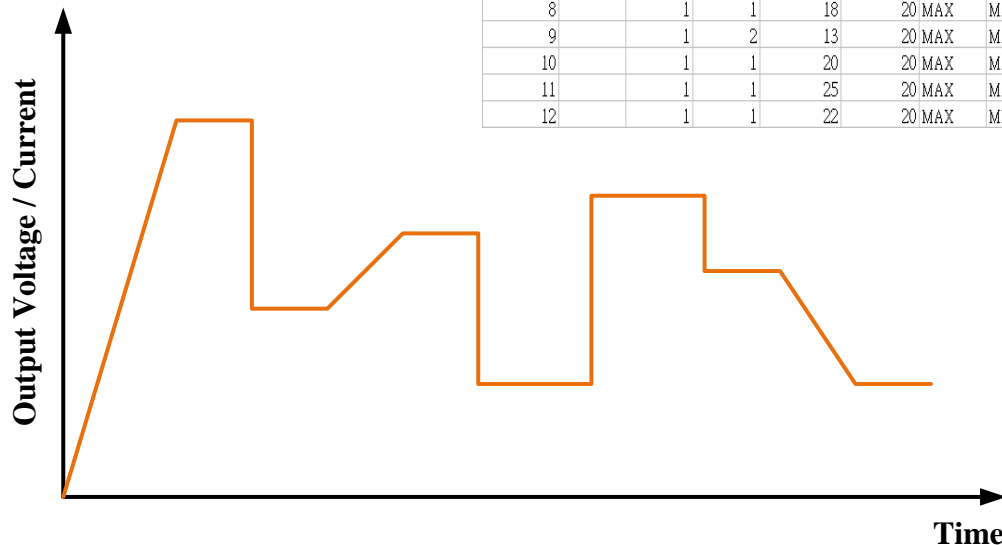
- **Capacitors discharge slowly under light loads**
 - ✓ Static voltage power supply: no problem
- **Fall time**
 - ✓ Rapidly reduce the output voltage
 - ✓ Shorten discharge times by hundreds of milliseconds



Unique Feature: TEST Sequence



Step	Point	Output	Time(sec)	Voltage (V)	Current (A)	OVP(V)	OCF(A)	Bleeder	IV Mode	Vsr up(V/s)	Vsr down(V/s)	Isr up(A/s)	Isr down(A/s)	IR(ohm)	Beeper	Sense Average	Jump to	Jump Cnt
1	start	1	3	10	20	MAX	MAX		1 CVHS	MAX	MAX	MAX	MAX		OFF	2		
2		1	5	20	20	MAX	MAX		1 CVHS	MAX	MAX	MAX	MAX		OFF	2		
3		1	2	30	20	MAX	MAX		1 CVHS	MAX	MAX	MAX	MAX		OFF	2		
4		1	3	40	20	MAX	MAX		1 CVHS	MAX	MAX	MAX	MAX		OFF	2		
5	end	1	2	50	20	MAX	MAX		1 CVHS	MAX	MAX	MAX	MAX		OFF	2	1	2
6		1	3	25	20	MAX	MAX		1 CVHS	MAX	MAX	MAX	MAX		OFF	2		
7		1	1	12	20	MAX	MAX		1 CVHS	MAX	MAX	MAX	MAX		OFF	2		
8		1	1	18	20	MAX	MAX		1 CVHS	MAX	MAX	MAX	MAX		OFF	2		
9		1	2	13	20	MAX	MAX	ON	CVHS	MAX	MAX	MAX	MAX		OFF	2		
10		1	1	20	20	MAX	MAX	ON	CVHS	MAX	MAX	MAX	MAX		OFF	2		
11		1	1	25	20	MAX	MAX	ON	CVHS	MAX	MAX	MAX	MAX		OFF	2		
12		1	1	22	20	MAX	MIN	ON	CVHS	MAX	MAX	MAX	MAX			2		



- Allows power supply to output a waveform like an Arbitrary Waveform Generator (ARB)
- TEST Sequence can change the output faster than a PC can send commands

Key Specification for DC Power Supply

- **CV Mode**
 - ✓ **Line Regulation**
 - ✓ **Load Regulation**
 - ✓ **Ripple and Noise**
 - ✓ **Transient Recovery Time**
 - ✓ **Rise Time / Fall Time**
- **CC Mode**
 - ✓ **Line Regulation**
 - ✓ **Load Regulation**

CV Line Regulation

Definition:

The change, ΔV_{out} , in the static value of DC output voltage resulting from a change in AC input voltage over the specified range from low line to high line, or from high line to low line.

Specifications :

Keysight: N5766A

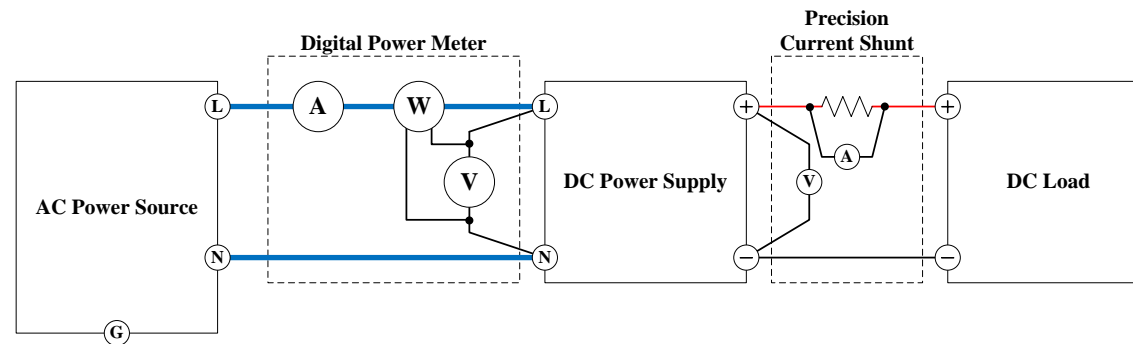
Source Effect $\leq 6\text{mV}$ (change from 85-132 VAC input or 170-265 VAC input)

GW Instek: PSU 40-38

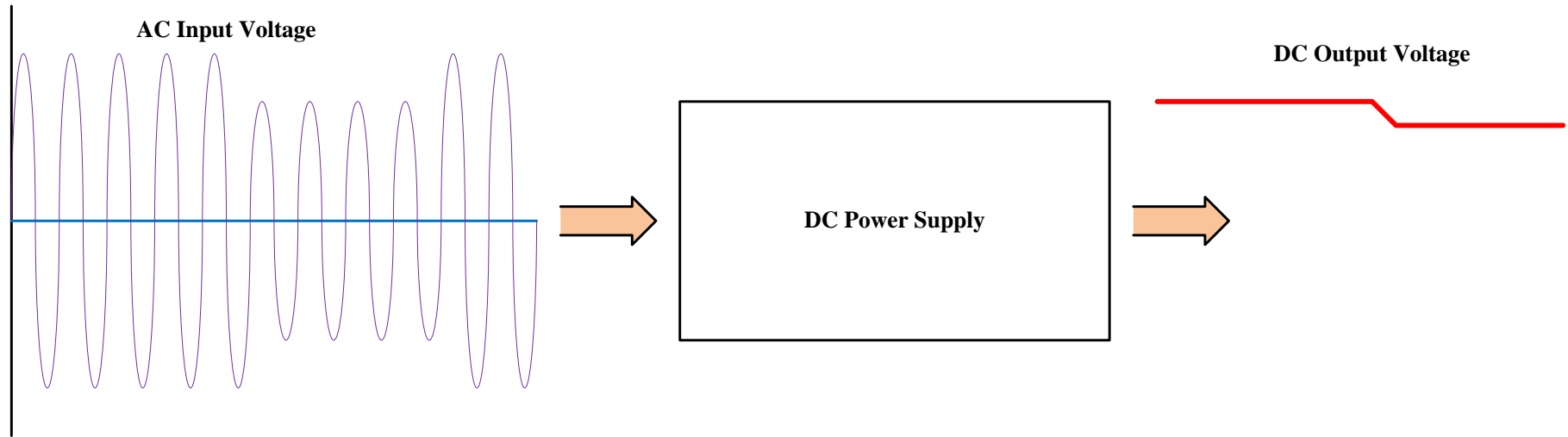
Line regulation $\leq 6\text{mV}$ (At 85-132Vac or 170-265Vac, constant load.)

Connection :

Line / Load Regulation, Steady State Data



CV Line Regulation



CV Load Regulation

Definition:

The change, ΔV_{out} , in the static value of DC output voltage resulting from a change in load resistance from open circuit to a value which yields maximum rated output current (or vice versa).

Specifications :

Keysight: N5766A

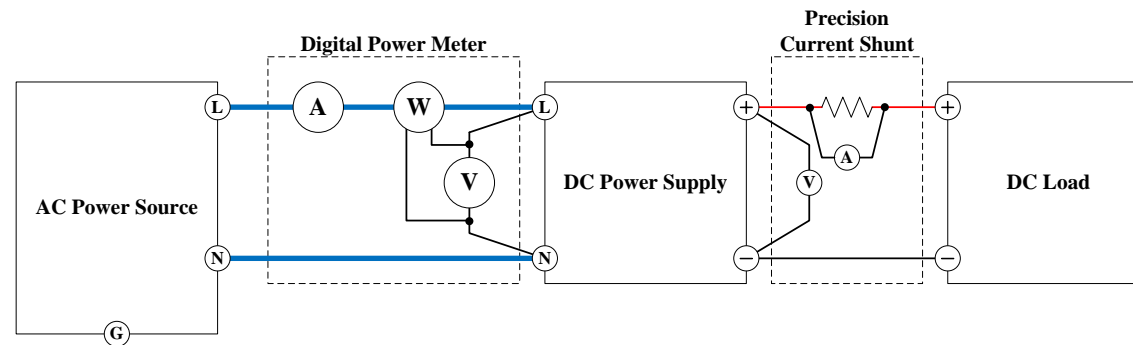
Load Effect $\leq 6\text{mV}$ (change from 10% to 90% of full load)

GW Instek: PSU 40-38

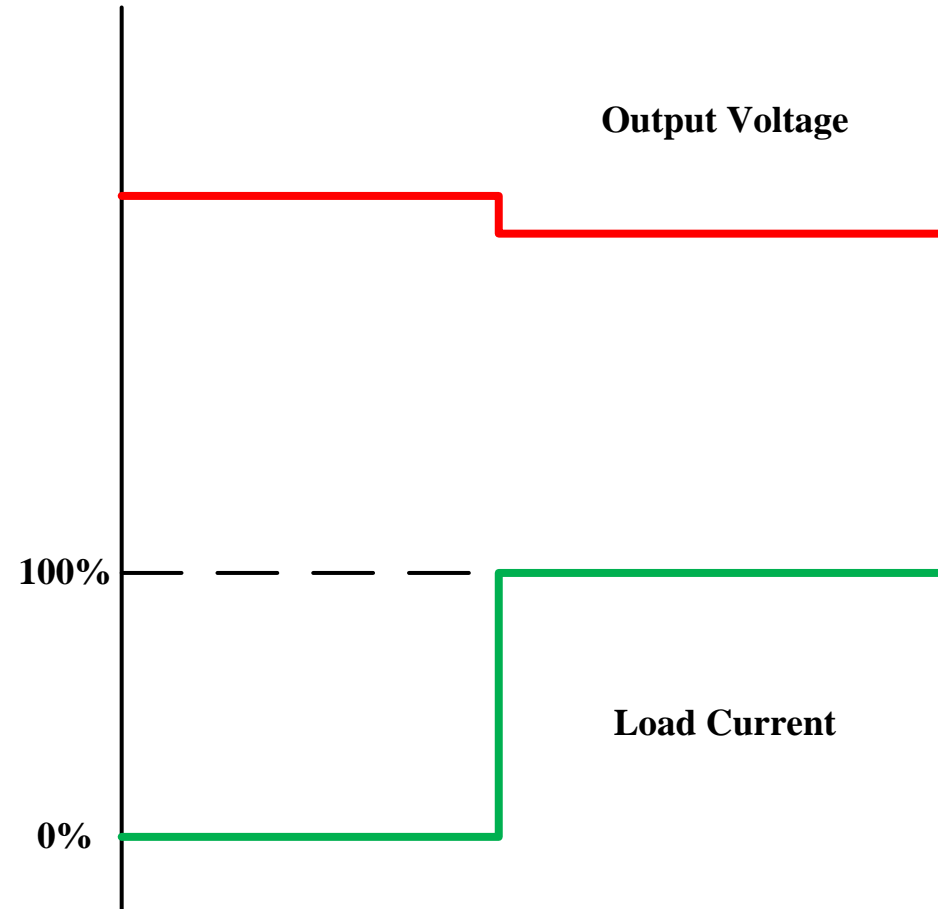
Load regulation $\leq 6\text{mV}$ (From No-load to Full-load, constant input voltage. Measured at the sensing point in Remote Sense.)

Connection :

Line / Load Regulation, Steady State Data



CV Load Regulation



CV Ripple and Noise

Definition:

The residual AC voltage which is superimposed on the DC output of a regulated power supply. Ripple and noise may be specified and measured in terms of its RMS or (preferably) peak-to-peak value.

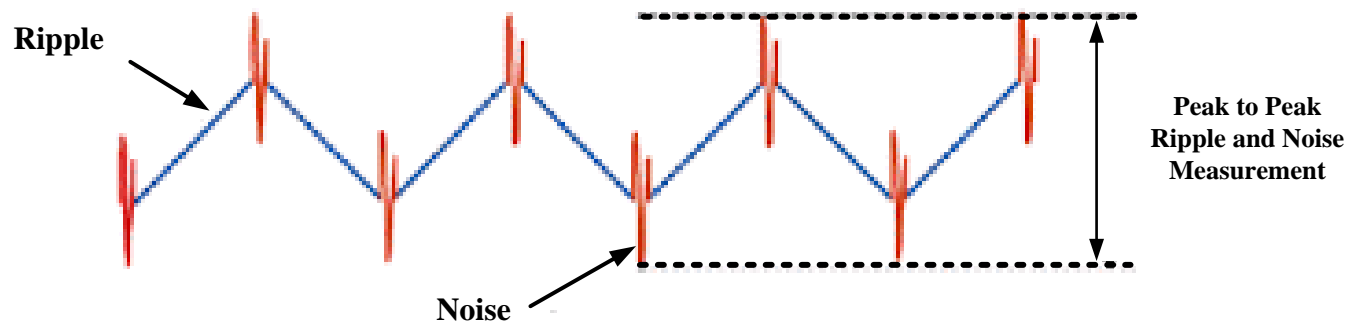
Specifications :

Keysight: N5766A

Output Ripple and Noise: $CV_{p-p} \leq 60mV$ (20MHz)
 $CV_{rms} \leq 8mV$ (From 5Hz - 1MHz)

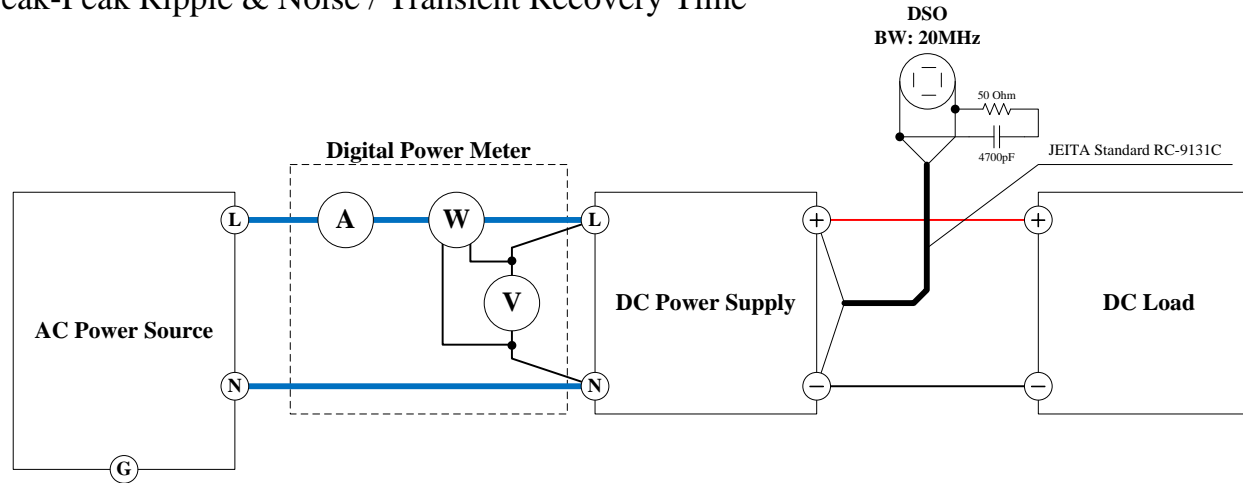
GW Instek: PSU 40-38

Output Ripple and Noise: $CV_{p-p} \leq 60mV$ (Measurement frequency bandwidth is 10Hz to 20MHz.)
 $CV_{rms} \leq 8mV$ (Measurement frequency bandwidth is 5Hz to 1MHz.)

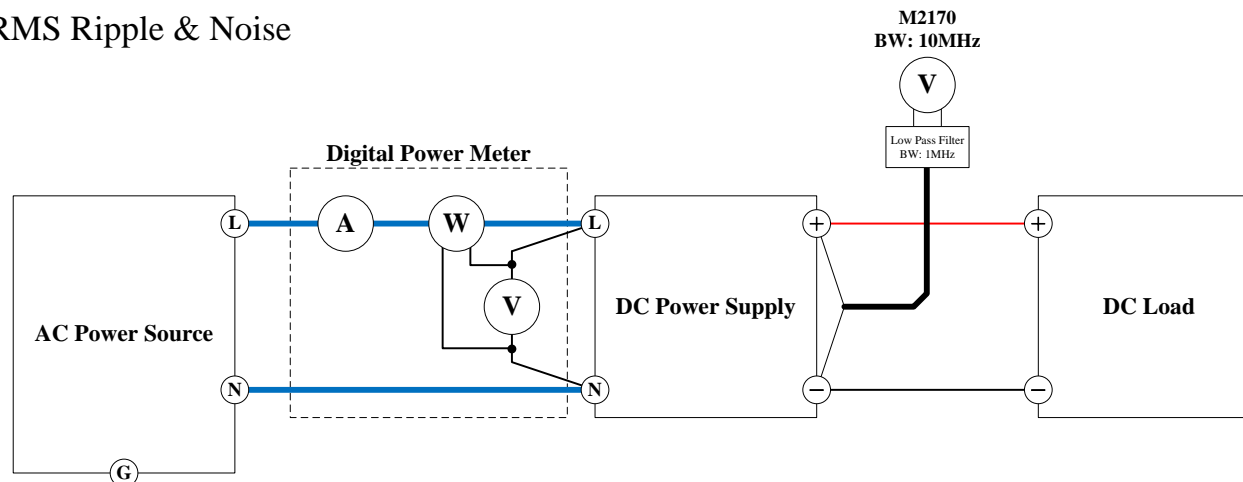


CV Ripple and Noise

Connection : Peak-Peak Ripple & Noise / Transient Recovery Time



RMS Ripple & Noise



CV Transient Recovery Time

Definition:

The transient recovery time is the time from when the load current begins to increase (coincident with the output voltage beginning to drop) to when the output voltage settles within a specified settling band around the final voltage value.

Specifications :

Keysight: N5766A

Load Transient Recovery Time $\leq 1\text{ms}$

(time for output voltage to recover within 0.5% of its rated output for a load change from 10 to 90% of its rated output current. Voltage set point from 10% to 100% of rated output)

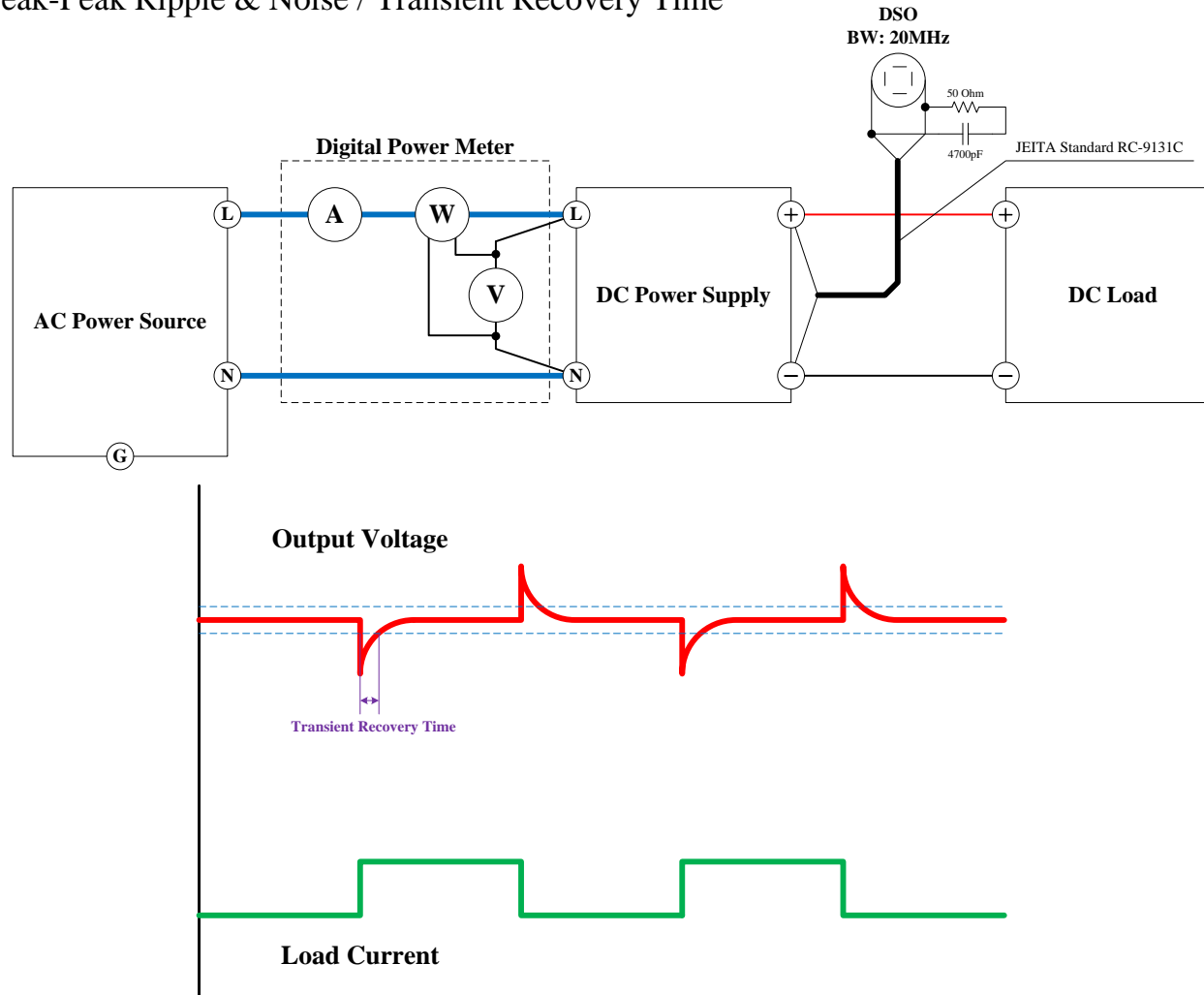
GW Instek: PSU 40-38

Transient Response Time $\leq 1\text{ms}$

(Time for output voltage to recover within 0.5% of its rated output for a load change from 10 to 90% of its rated output current. Voltage set point from 10% to 100% of rated output.)

CV Transient Recovery Time

Connection : Peak-Peak Ripple & Noise / Transient Recovery Time



CV Rise Time and Fall Time

Specifications :

Keysight: N5766A

Output Response Time: (to settle to within 1.0% of the rated output, with a resistive load)

Up, full load $\leq 0.08s$

Down, full load $\leq 0.08s$

Down, no load $\leq 1.0s$

GW Instek: PSU 40-38

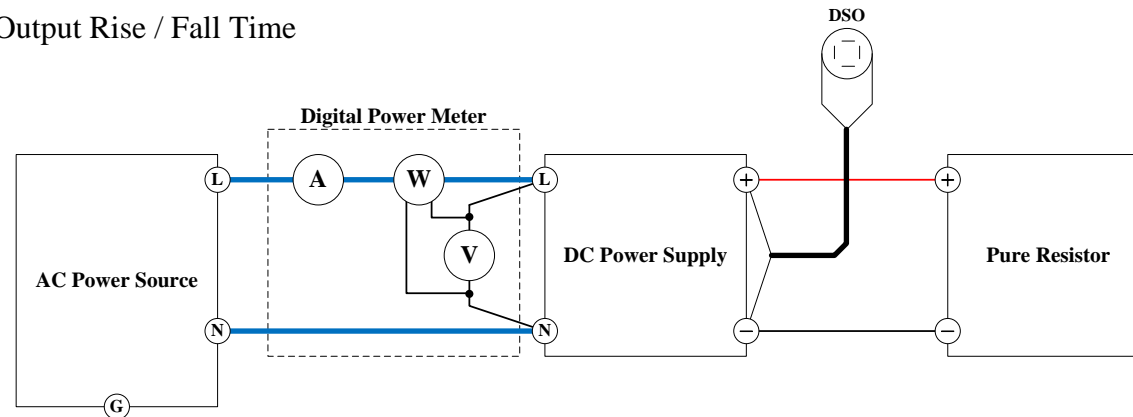
Rise time Rated load $\leq 80ms$ No load $\leq 80ms$

(From 10% to 90% of rated output voltage, with rated resistive load.)

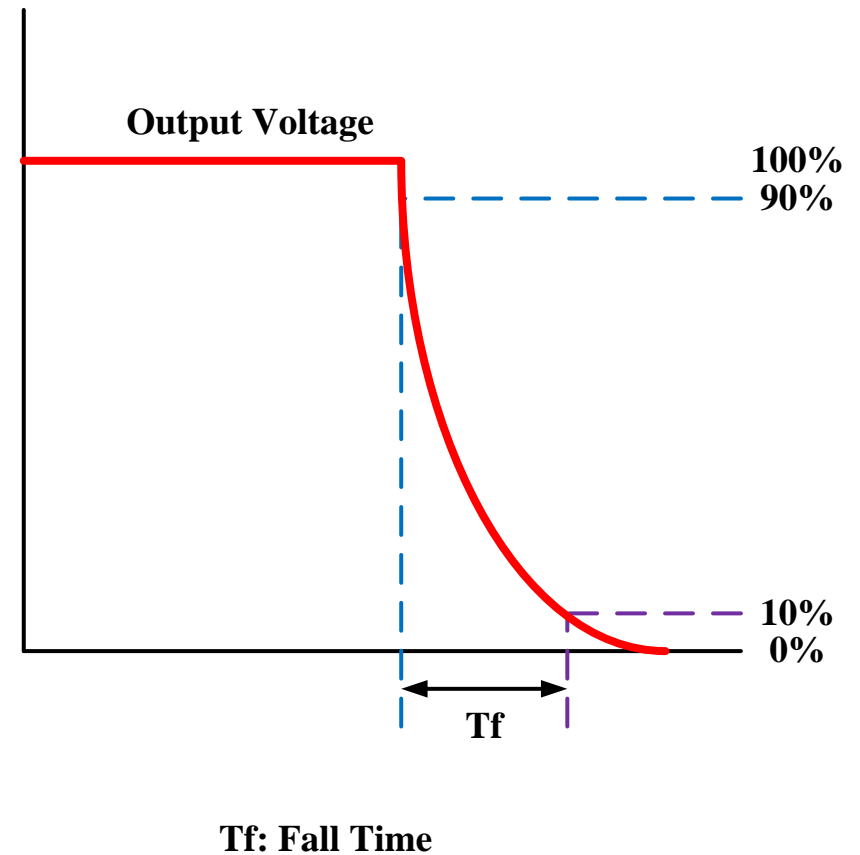
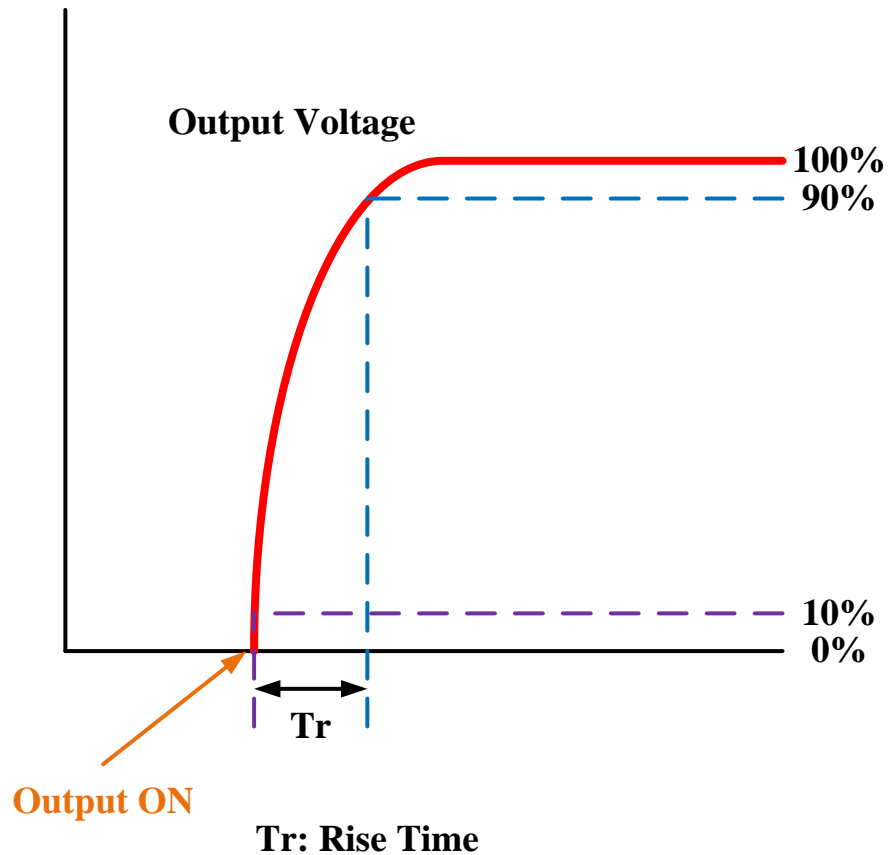
Fall time Rated load $\leq 80ms$ No load $\leq 1000ms$

(From 90% to 10% of rated output voltage, with rated resistive load.)

Output Rise / Fall Time



CV Rise Time and Fall Time



CC Line Regulation

Definition:

The change, ΔI_{out} in the static value of DC output current resulting from a change in AC input voltage over the specified range from low line (usually 85 volts) to high line (usually 132 volts), or from high line to low line.

Specifications :

Keysight: N5766A

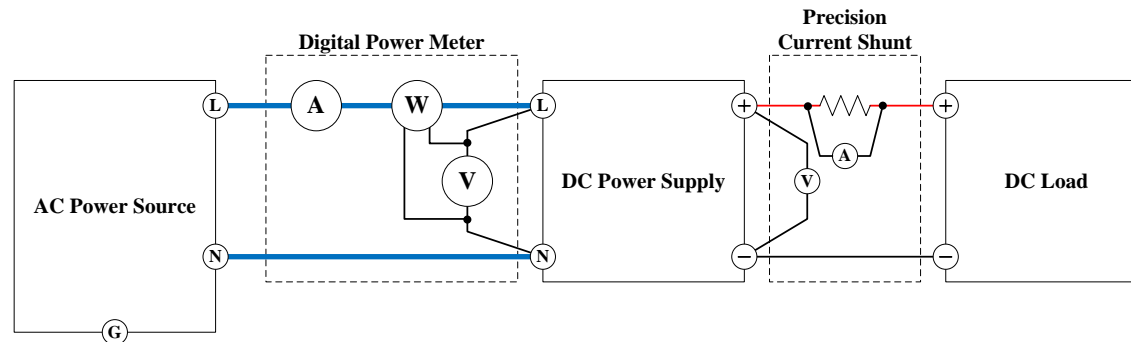
Source Effect $\leq 5.8\text{mA}$ (change from 85-132 VAC input or 170-265 VAC input)

GW Instek: PSU 40-38

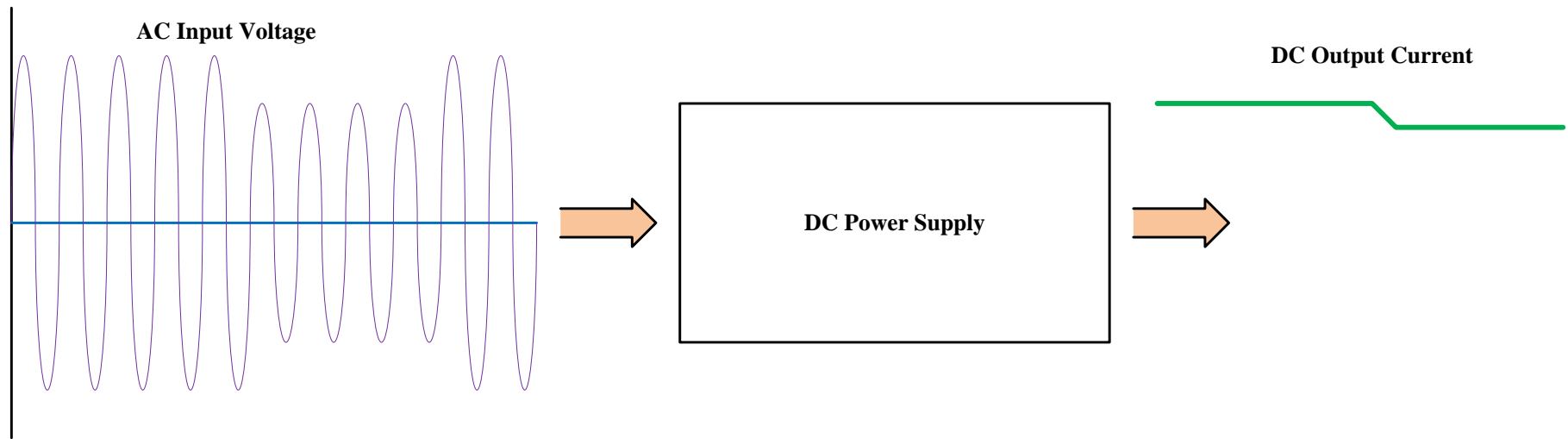
Line regulation $\leq 5.8\text{mV}$ (At 85 ~ 132Vac or 170 ~ 265Vac, constant load.)

Connection :

Line / Load Regulation, Steady State Data



CC Line Regulation



CC Load Regulation

Definition:

The change, ΔV_{out} , in the static value of DC output voltage resulting from a change in load resistance from open circuit to a value which yields maximum rated output current (or vice versa).

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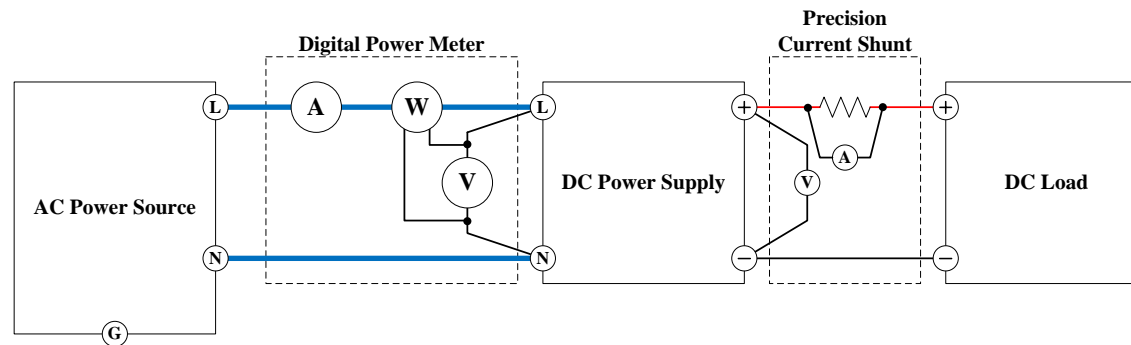
Load Effect $\leq 6\text{mV}$ (change from 10% to 90% of full load)

GW Instek: PSU 40-38

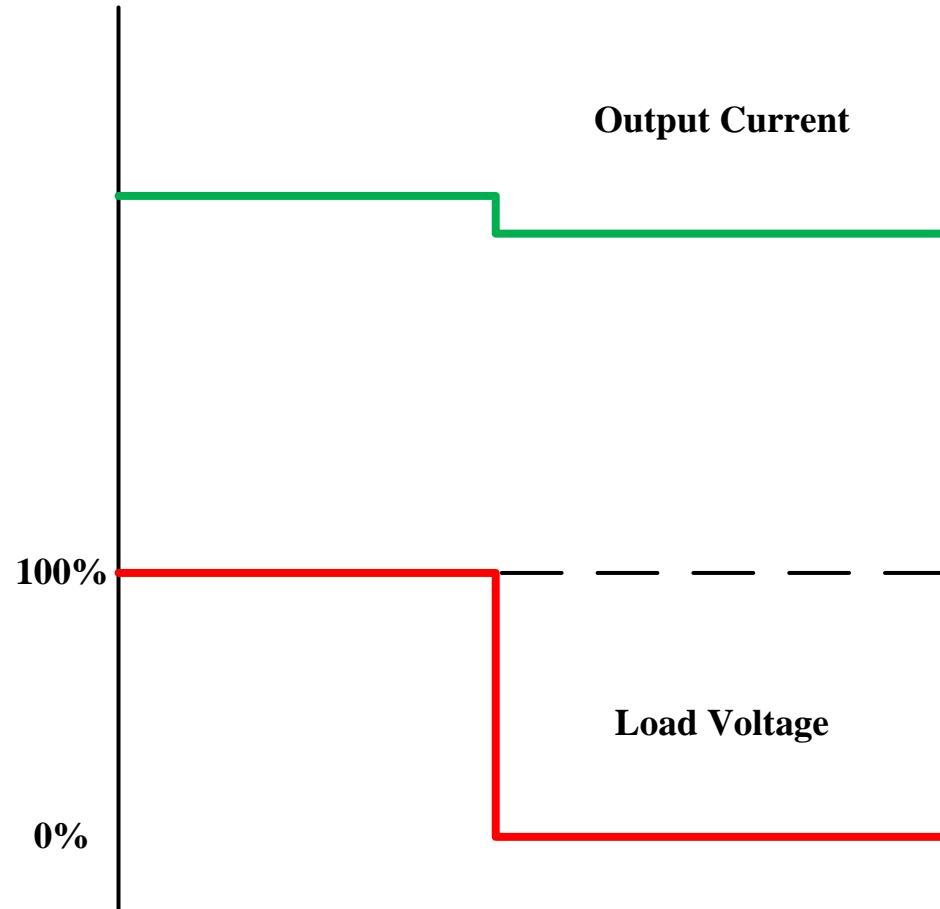
Load regulation $\leq 6\text{mV}$ (From No-load to Full-load, constant input voltage. Measured at the sensing point in Remote Sense.)

Connection :

Line / Load Regulation, Steady State Data



CC Load Regulation



Open Discussion



Case study

Cases Study

Case I

Requirement ? DUT → Capacitor

Need charge and discharge 1000 times for capacitor and charge current is reachable to 56A

Original Customer solution:

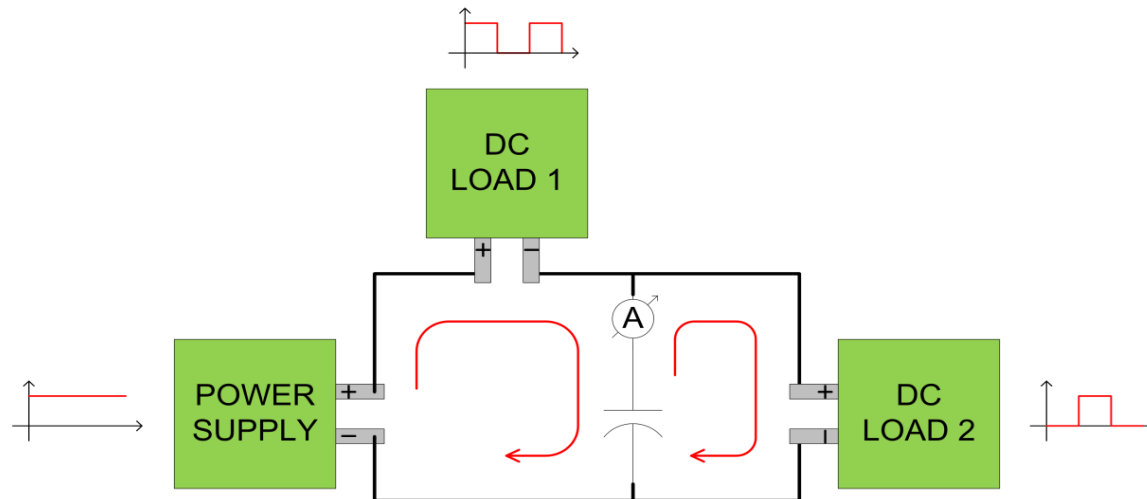
Execute Charge and discharge test manually

Cases Study

Case I

Solution:

- Power supply (charge to capacitor)
- DC load1 (current limit and switch control in charged path)
- DC load2 (capacitor discharge to DC load2)
- DC load1 & DC load2 switch mutually in order to implement charge and discharge test repeatedly .

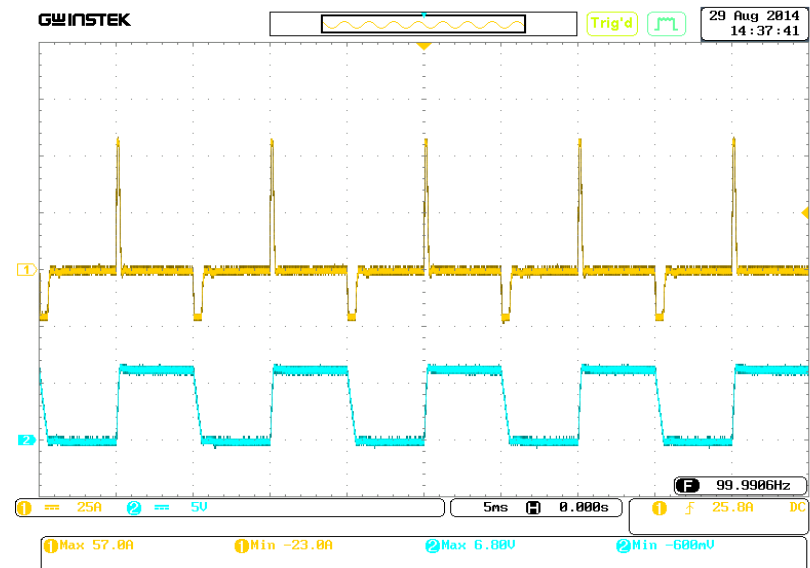
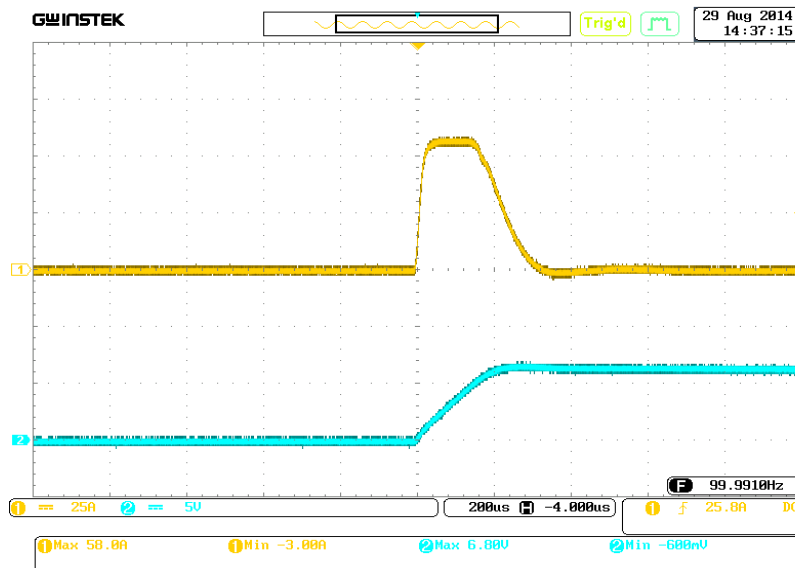


Cases Study

Case I

What benefit can we provide to customer?

- 1 It merely took 10sec in 1000 times of charge and discharge test.
- 2 It increased measurement stability and decreased measurement time.

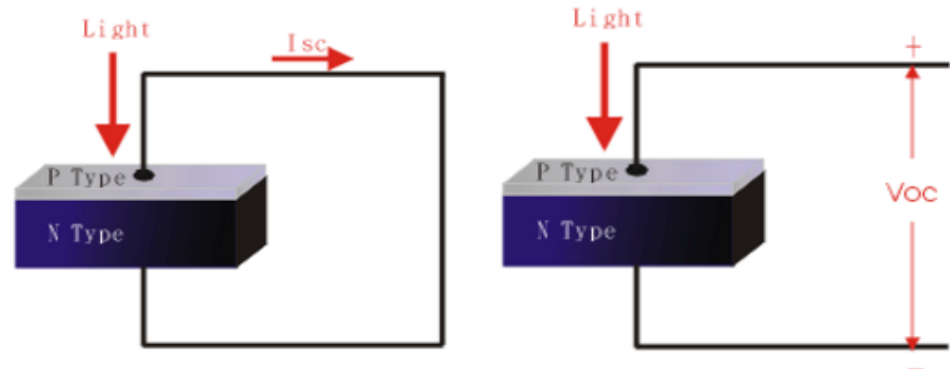
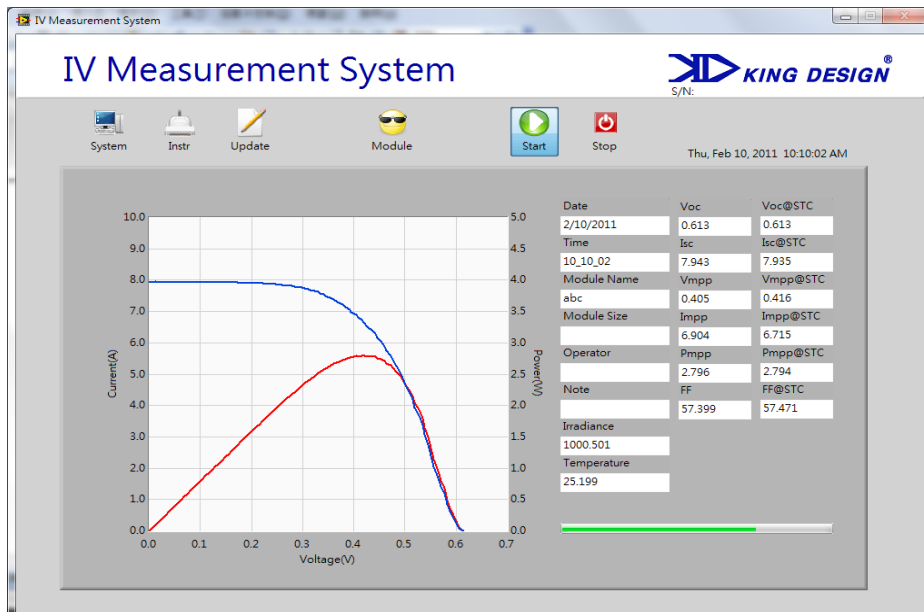


Cases Study

Case II

Requirement?

Obtain VI curve of solar cell.



I_{sc} : Short current from Solar cells positive terminal to negative terminal

V_{oc} : open voltage of solar cell's for two terminals

Cases Study

Case II

Analysis:

In order to get Voltage value of solar cell so as to utilize sequence function of DC load simulating current variation and trigger out to synchronize DMM for measurements.

Solution!

Sequence function of DC load + Trigger out

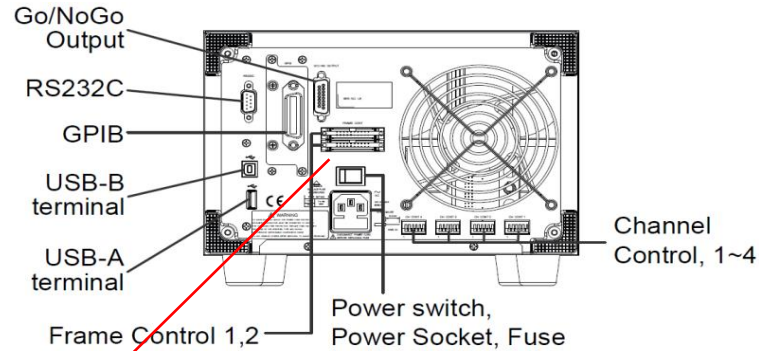
Automatic measurements voltage when programmable current is executed.

Cases Study

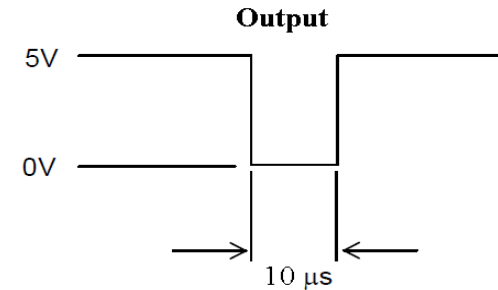
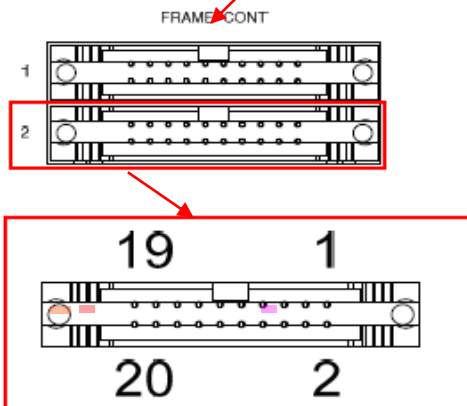
Implementation!

Case II

Goodwill PEL-200x



Pin 4 **TRIG_OUT**



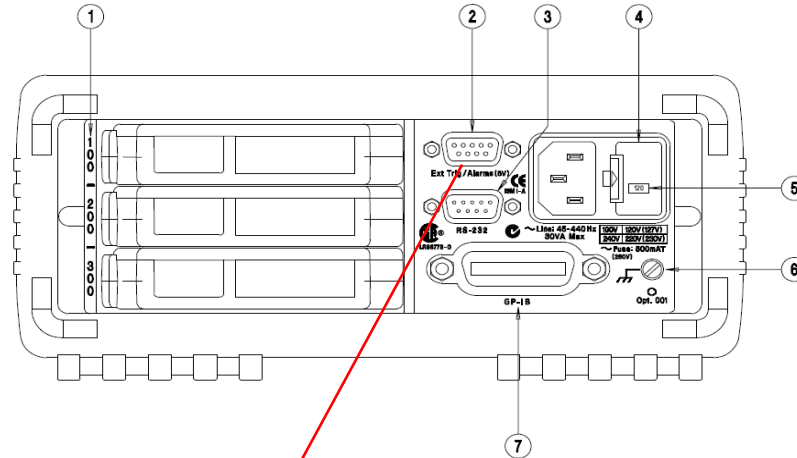
Pin 18 **5V (100mA)**

Pin 19,20 **GND**

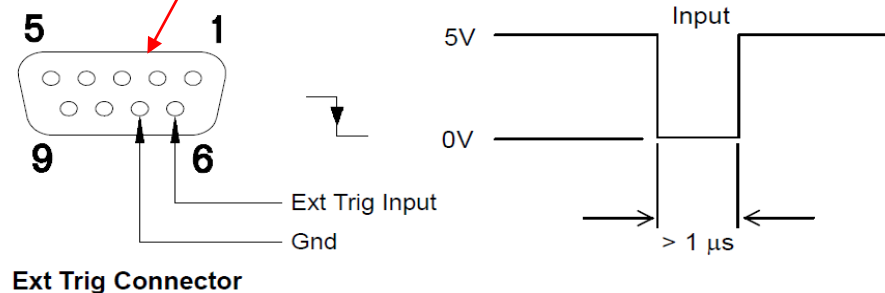
Cases Study

Case II

Implementation!



External Scanning In this configuration, the instrument sweeps through the scan list once each time a low-going TTL pulse is received on the rear-panel *Ext Trig Input* line (pin 6).



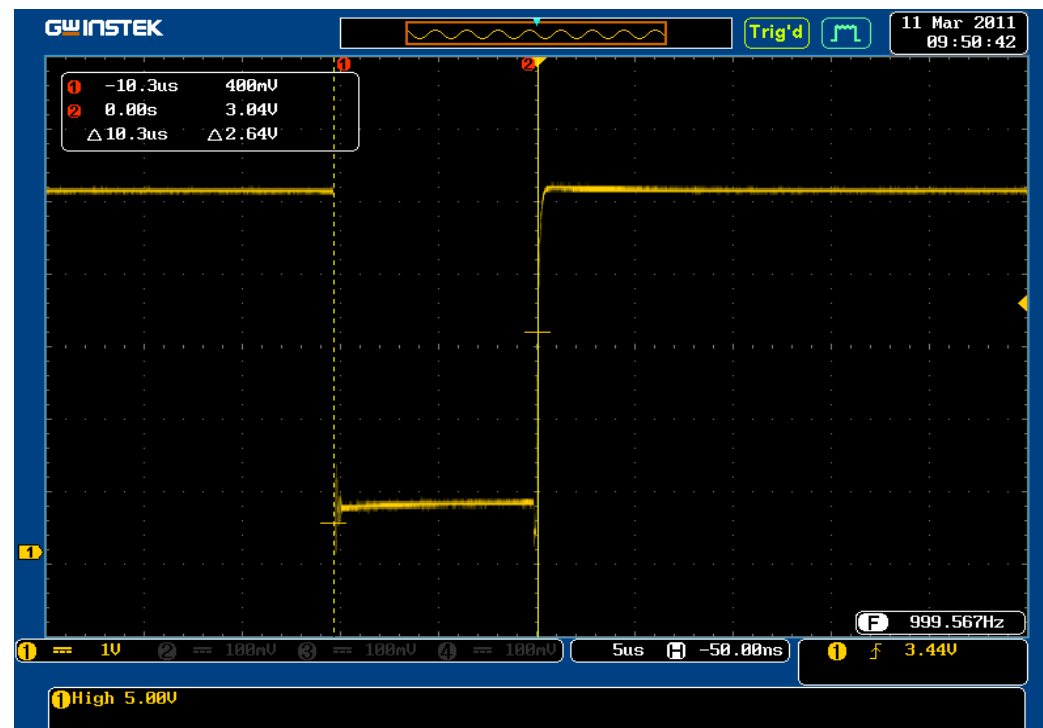
Cases Study

Trigger Connections

Case II

Goodwill PEL-200x

Agilent 34970A



Cases Study

Case III

Requirement ?

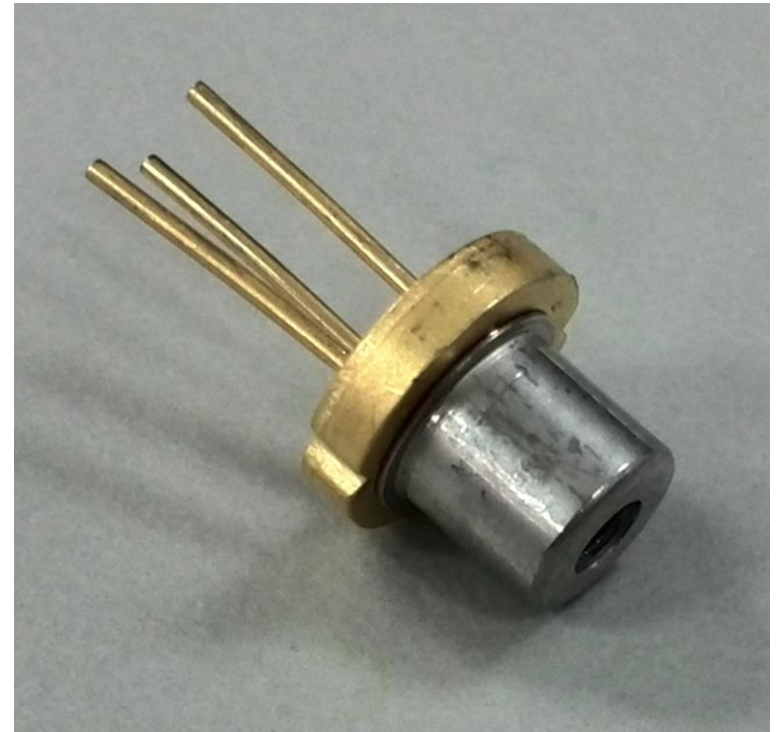
- 1 Sink current without over shoot
- 2 Want to Sink 1 ms pulse current

Test conditions:

Voltage: Under 3V

Current: 50mA

DUT → Laser Diode



Cases Study

Case III

Solution:

Power supplies + Electric Load

Cases Study

Case III

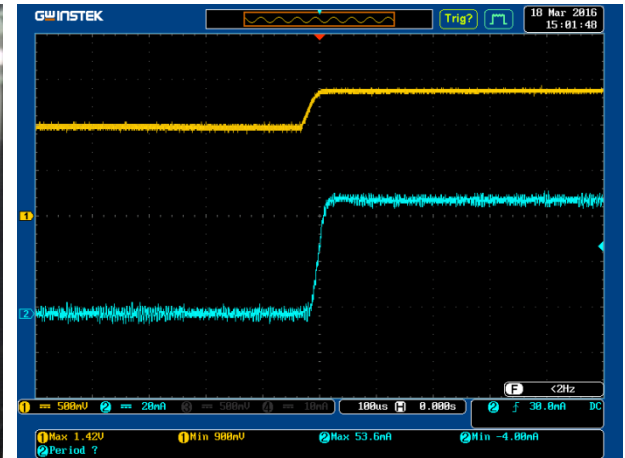
Solution: Power supply + Electric Load



Set
Voltage: 3V
Current 0.05A
Output ON



DC Load as
0.05A in CC
mode

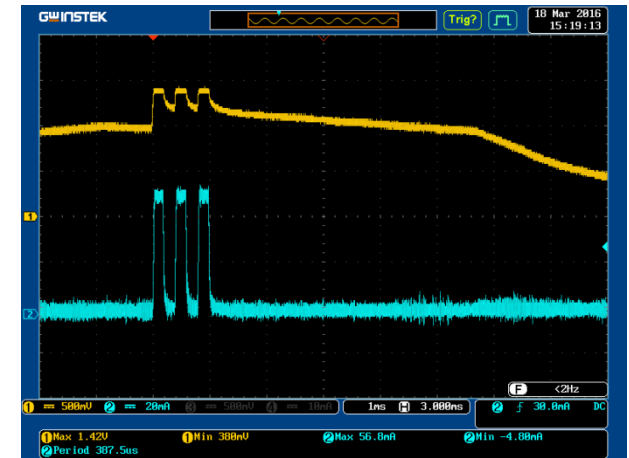
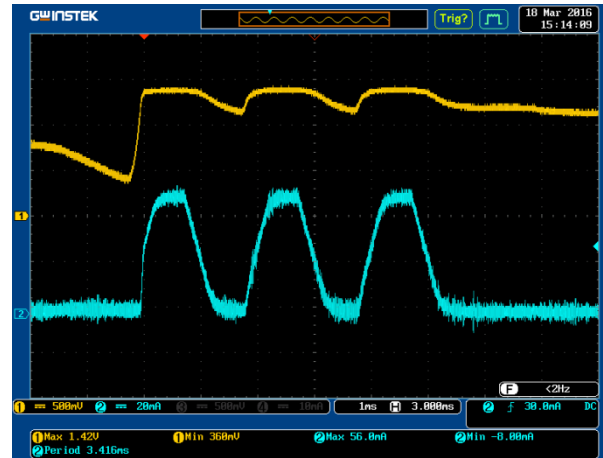
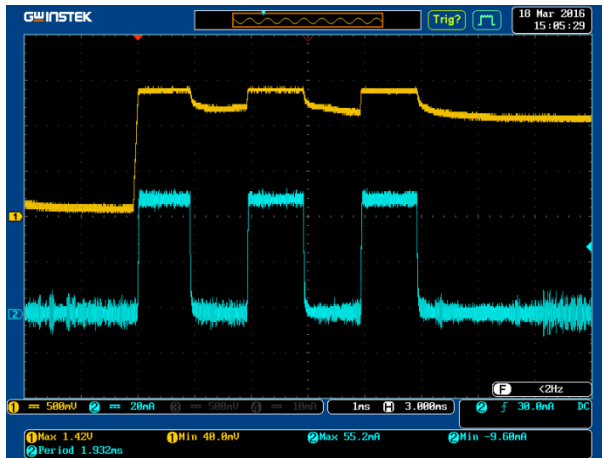


No overshoot

Cases Study

Case III

Solution: Power supply + Electric Load



Use high speed features of PEL-3000 to adjust slew rate of rising and falling.

(above pulse width: 1ms)

The waveform of slowing down the slew rate of rising and falling

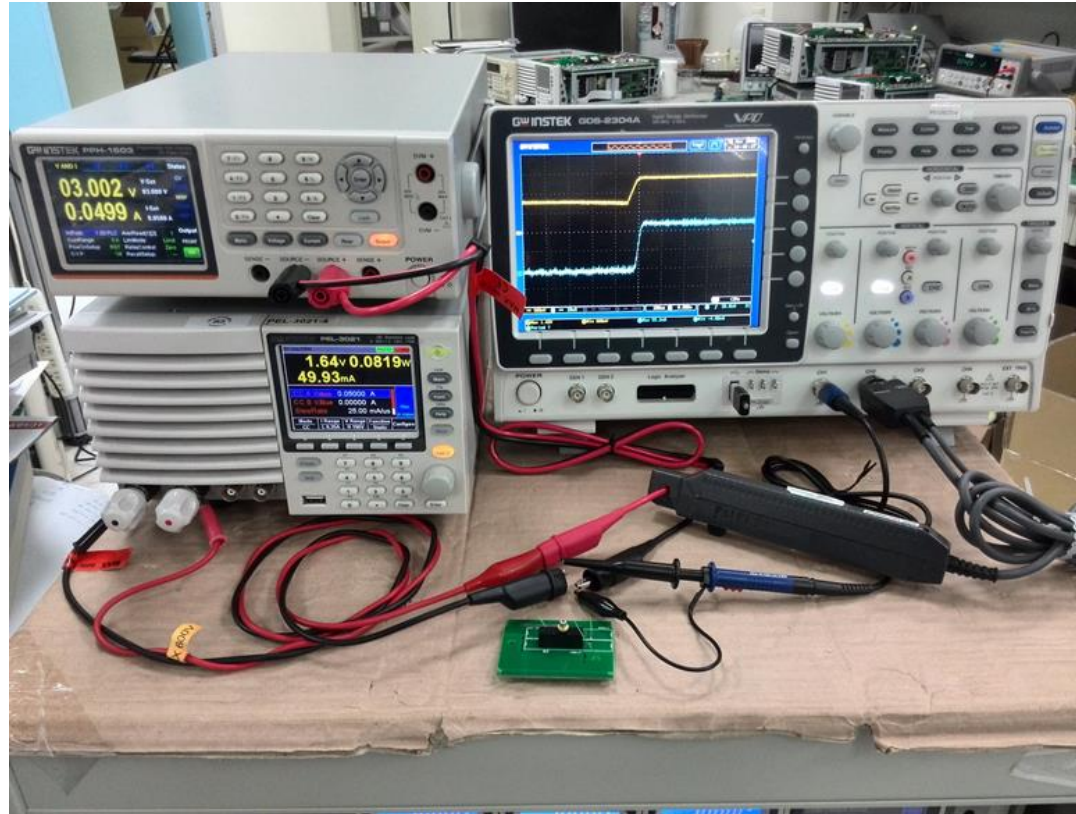
Capability of PEL-3000

The fastest speed of pulse is 25us.

Cases Study

Case III

Conclusion:



Power supply+ PEL-3000 is ideal for produce a continuous pulse current.

Cases Study

Case IV

Requirement ? DUT → A rechargeable Battery

- 1 An automation for Charge/ Discharge test**
- 2 Plot the chart for the analysis**
- 3 Export to Excel file**

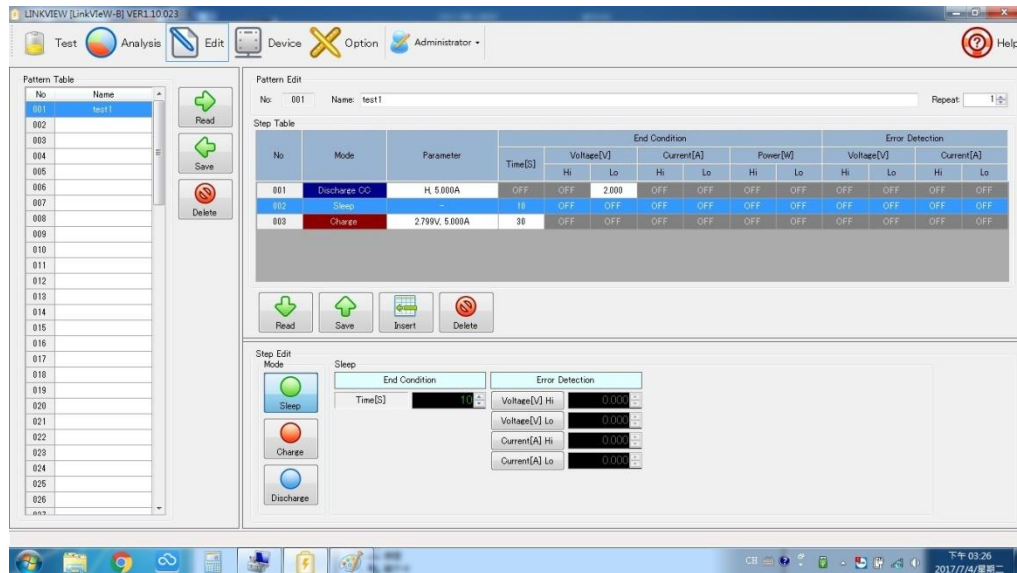
Solution:

Software tool: *LinkView*

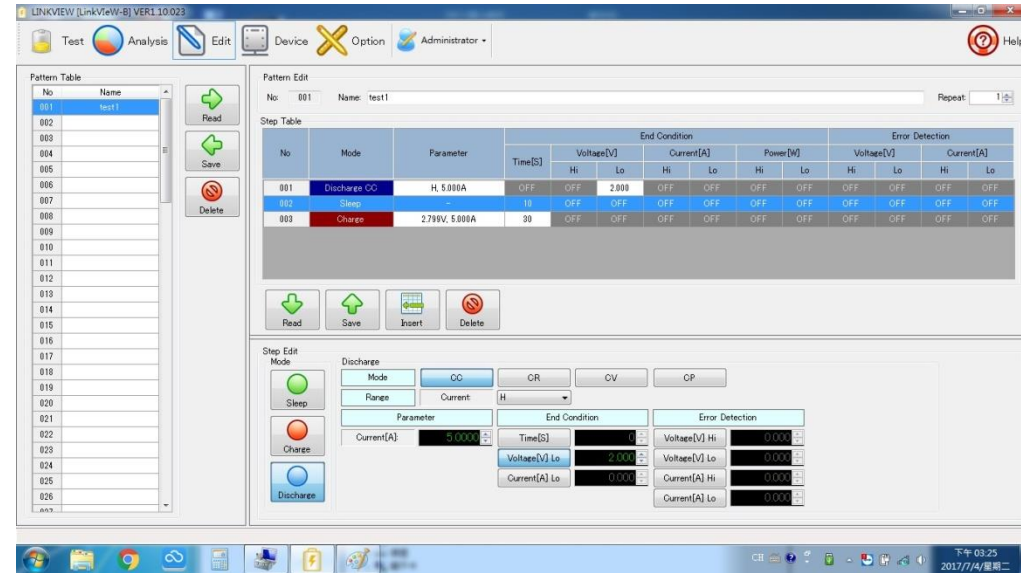
Cases Study

Case IV

GW Instek provides User the PC software to conduct battery Charge/ Discharge test in Automation.



Charge setting

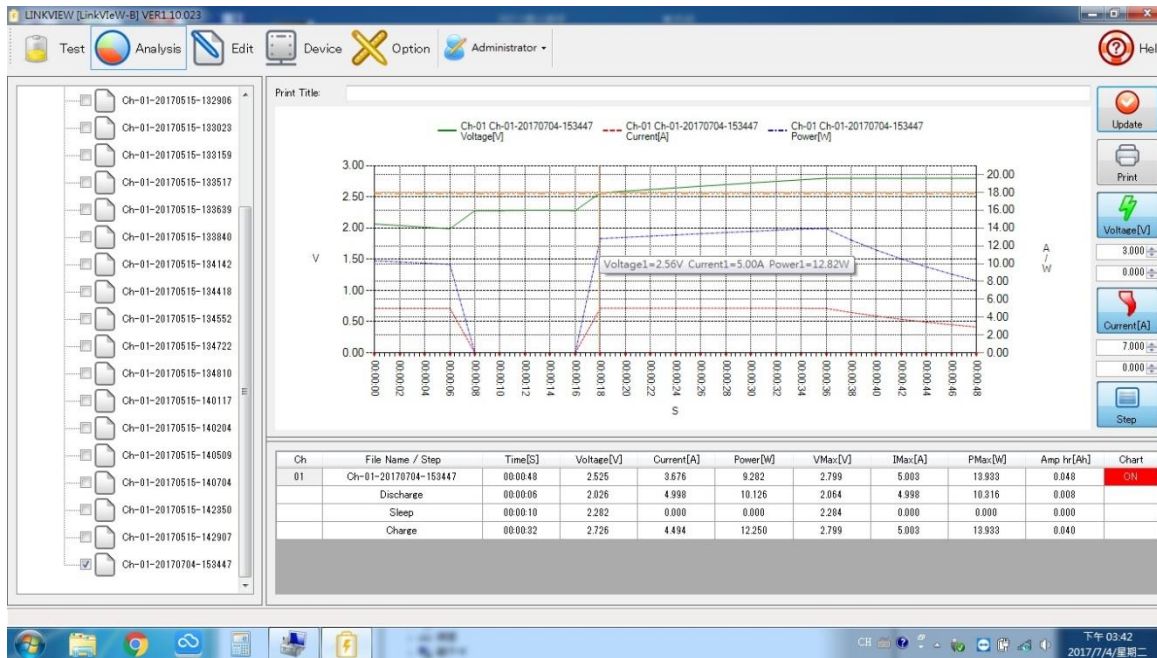


Discharge setting

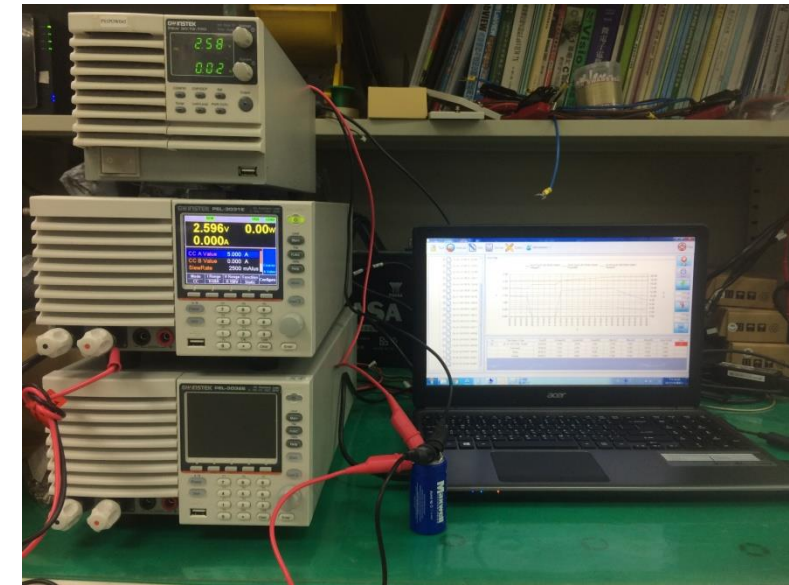
Cases Study

Case IV

Result:



Test result



Connection

Key Factor for Application

Micro resistor test

Application

- Production line

Product

- PSU 6-200 x 3 sets



Micro resistor test

KSF

1. Need a 600A current with 3U height to verify their micro resistor products

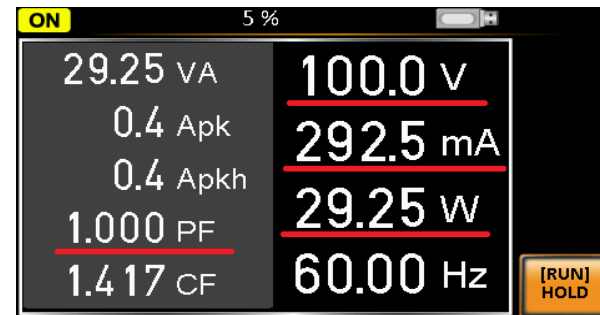
LED test

Application

- Production line

Product

- APS-7050



LED test

KSF

1. high resolution of current(0.01mA)

2. V, I, P, PF, F, CF, S, Ipeak, Ipk hold

Radiator fan

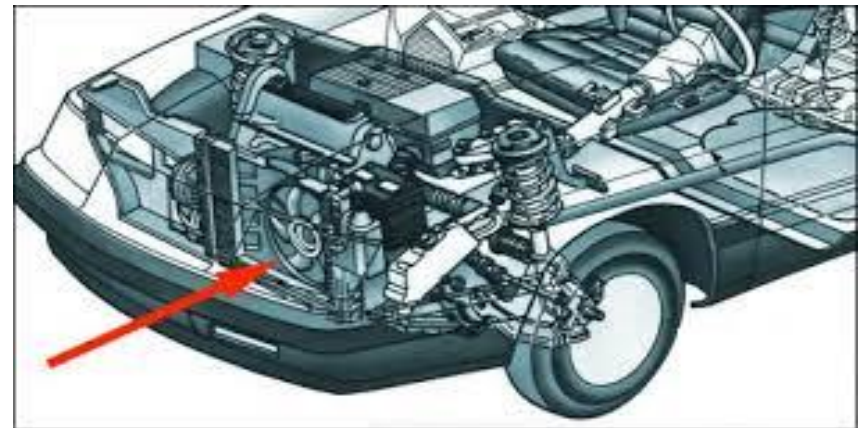
Application

- Production line



Product

- PSU 6-200 x 3 sets



Radiator fan

KSF

1. An automated Sequential power output(test script function)

Material research

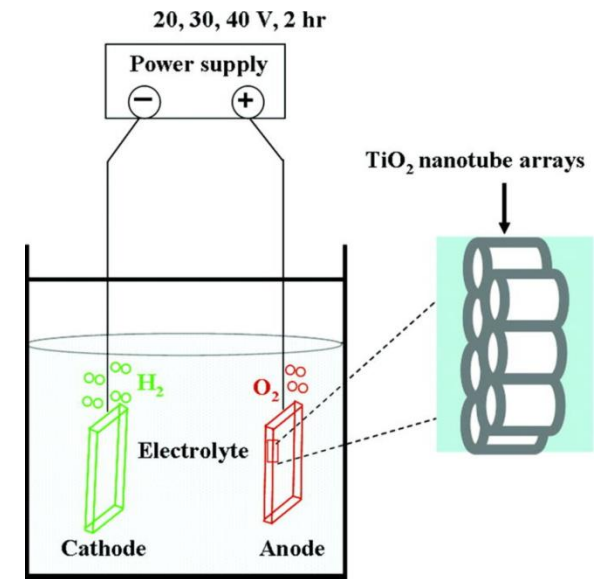
Application

- R&D

(Material research by anode oxidation)

Product

- PSW 250-13.5



Material research

KSF

- 1 Test Script is used for the application.
- 2 Supplies low voltage at low impedance state where a film is not formed, and then increases voltage gradually according to impedance increasing.

Ceramic capacitor/ Electrolytic capacitor

Application

- production engineering
(Aging test)



Product

- PSF-400H(PSB-2400)
- PSW 800-2.88(720W)



Ceramic capacitor/ Electrolytic capacitor

KSF

- 1 Competitors' products provide voltage up to 650V
- 2 We can provide up to 800V.
- 3 The PSB-2400H won the order of the Ceramic capacitor case, the PSW 800-2.88 won another order of the Electrolytic capacitor.

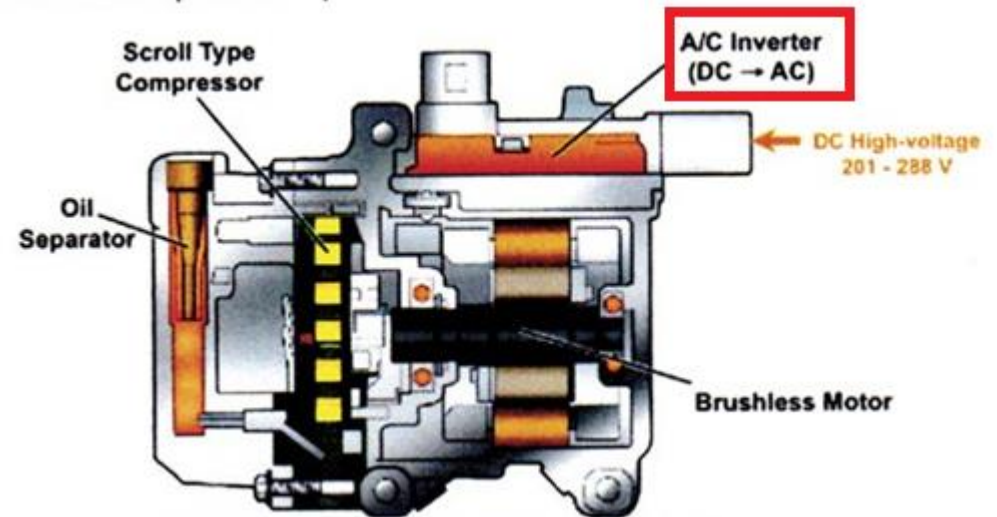
Inverter (Automotives)

Application

- Quality Assurance
(Evaluation of the inverter for hybrid car)

Product

- PCS-1000



Inverter (Automotives)

KSF

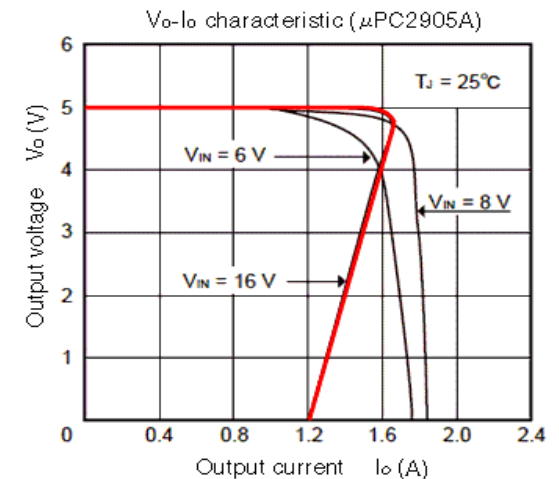
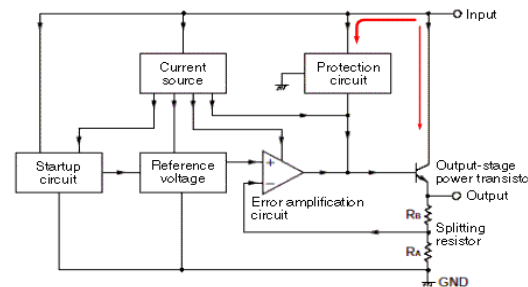
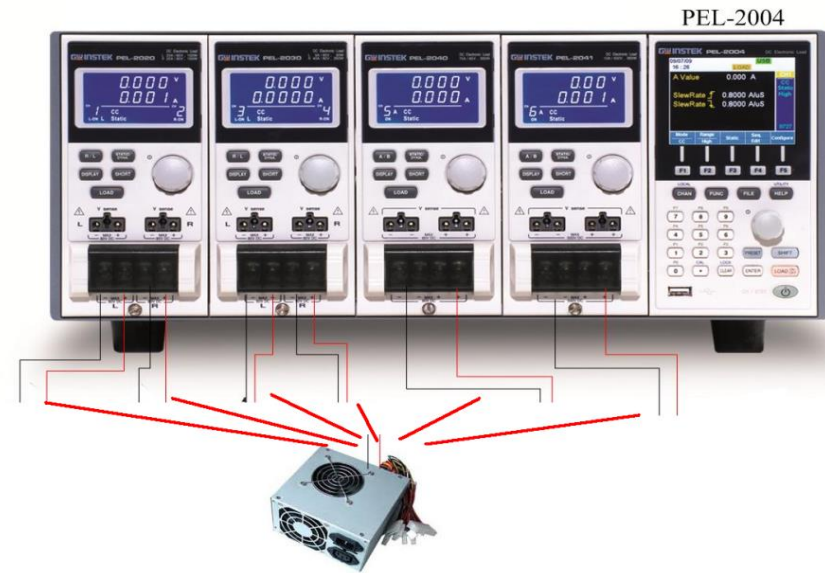
1. PCS-1000 can measure voltage up to 1000Vdc, while measure current up to 300A.
- 2 It might be used instead of Curve tracer.

Applications

PC Power Supply

Power Supply Test

- Output capacity Check (Minimum operating voltage)
 - CC/CV
 - CC/CR Mode
- Tr/Tf (From turn off to on)
 - Full Load / No Load
 - CR Mode
- Transient Response time
 - CC Mode
 - Dynamic Mode
- Fold-back Type Drooping Characteristic (I-V curve evaluation)
 - CR Mode(CV Mode)



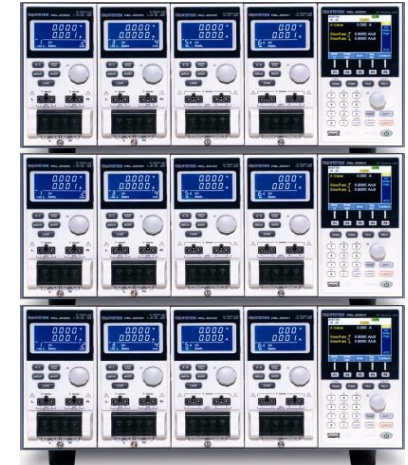
Fuse Test

Fuse Test

A limit test & spec. check



Power
Supply
(Battly)



一般仕様 (周囲温度: 24°C)

試験電流 (A)	溶断時間	
	最小	最大
定格電流の 110%	100 時間	---
定格電流の 135%	0.75 秒	1800 秒
定格電流の 200%	0.15 秒	5 秒
定格電流の 350%	0.04 秒	0.5 秒
定格電流の 600%	0.02 秒	0.2 秒

ヒューズの特性は使用状況により変化する場合があります。

定格電圧: DC32V以下

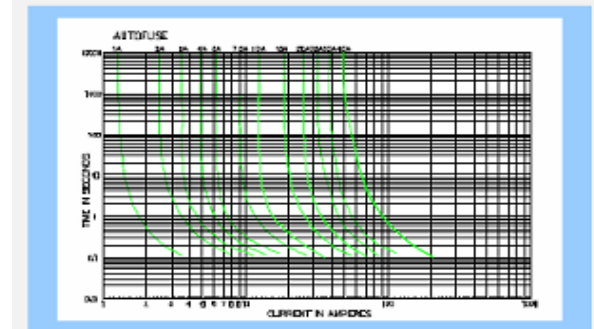
電流断続耐久性 (周囲温度: 24°C)

ヒューズに10秒ON、10秒OFFのパターンで定格電流の70%の電流を250,000回断続して与えた後でも性能を満足します。

雰囲気温度による容量変化

1°C当たり -0.15%の割合で容量が変化します。

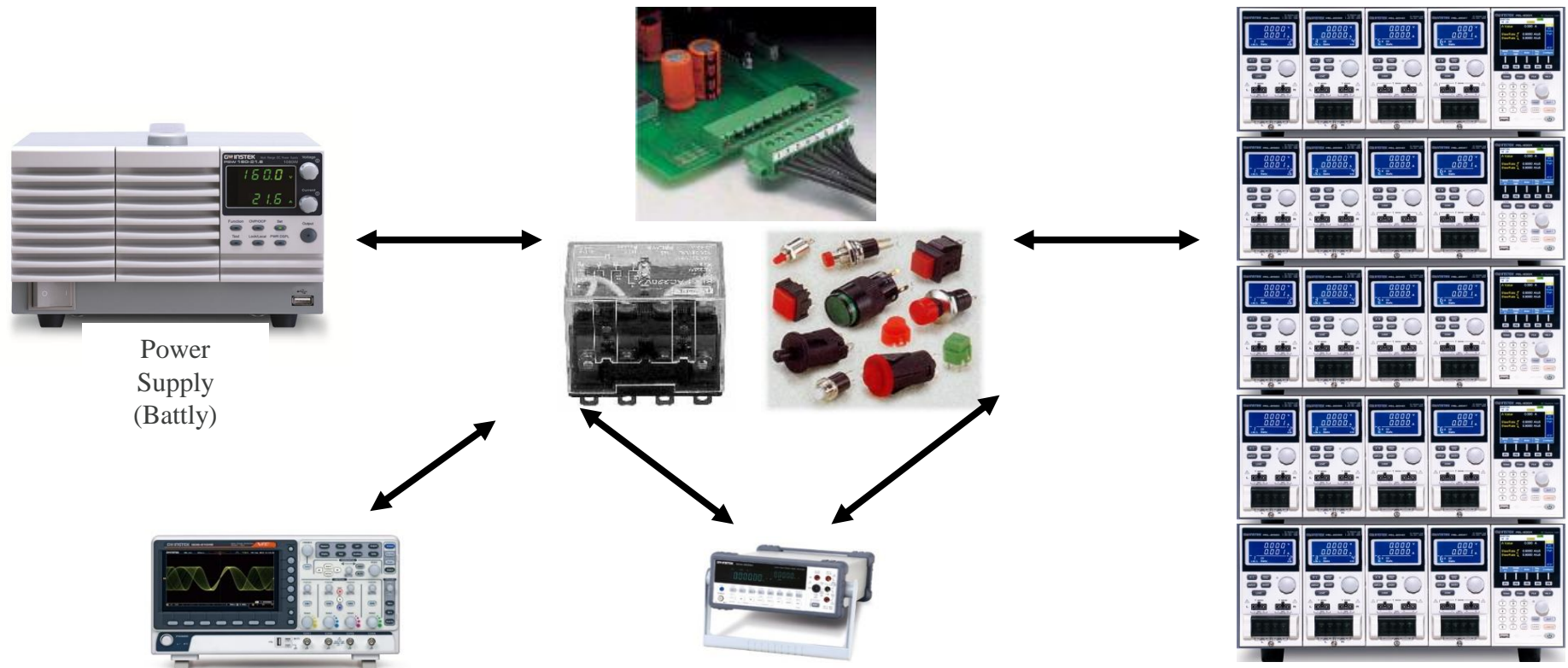
溶断特性



Switch/ Relay test

Switch/Relay Test

A limit test & endurable test

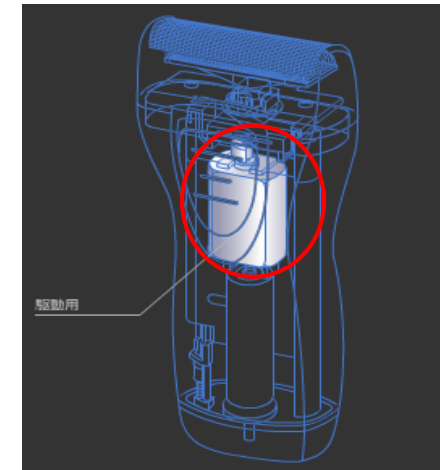
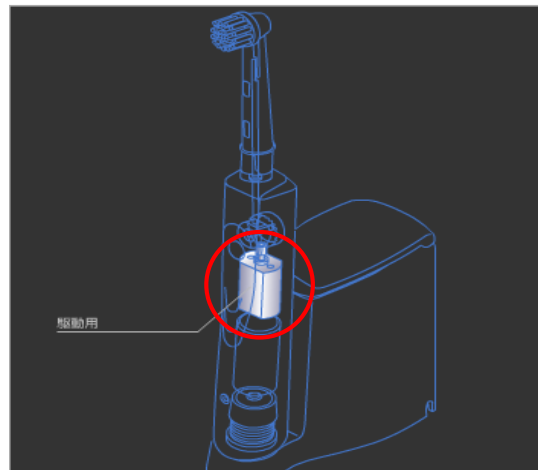
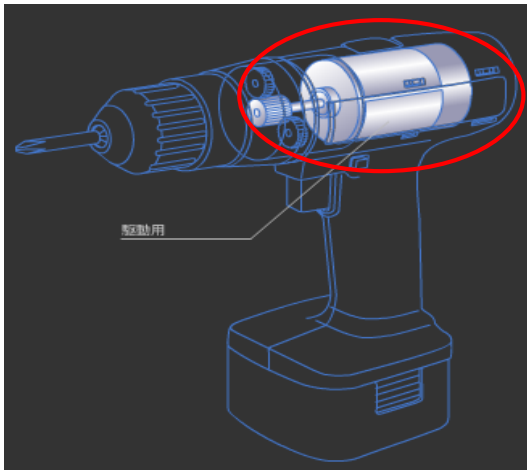


Power-driven tools

Power-driven tools simulation test



Measurement I

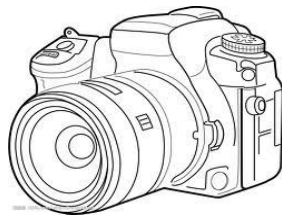


Pulse current application

- Mobile communication – actual test for charger circuit
- Digital Cameras - pulse discharge test ◦
 - CP pulse discharge for batteries
 - Camera Motor current driven (connected power supply in series)



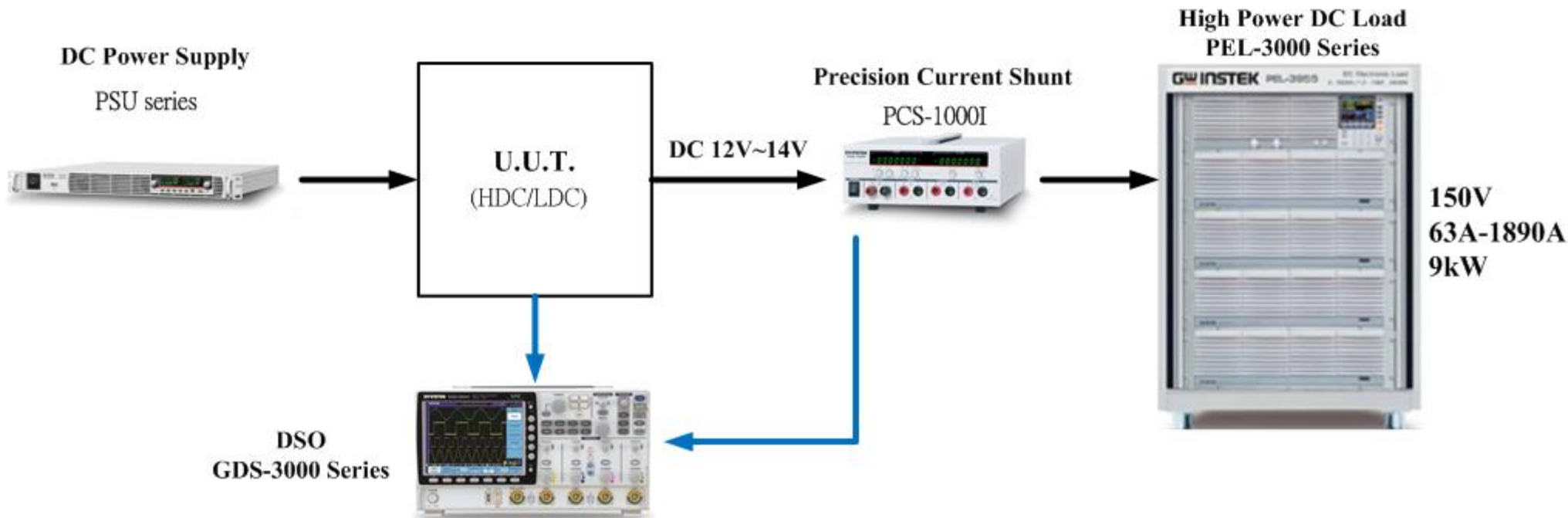
3506-3508
Brushless Motor For Micro Camera



EV/HEV

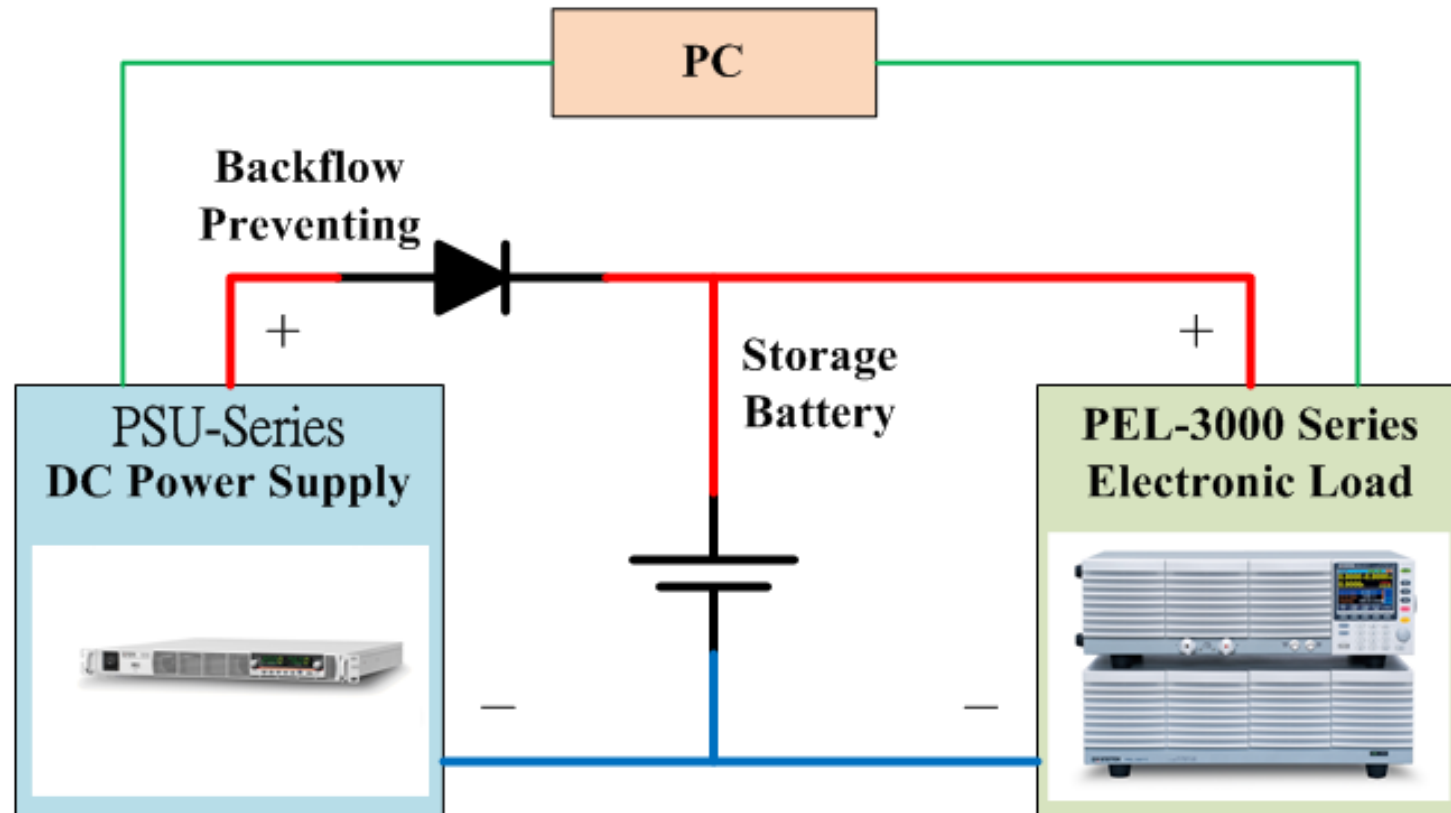
- Testing of DC / DC converter for the automotive industry

Output characteristic of the DC/DC Converter)



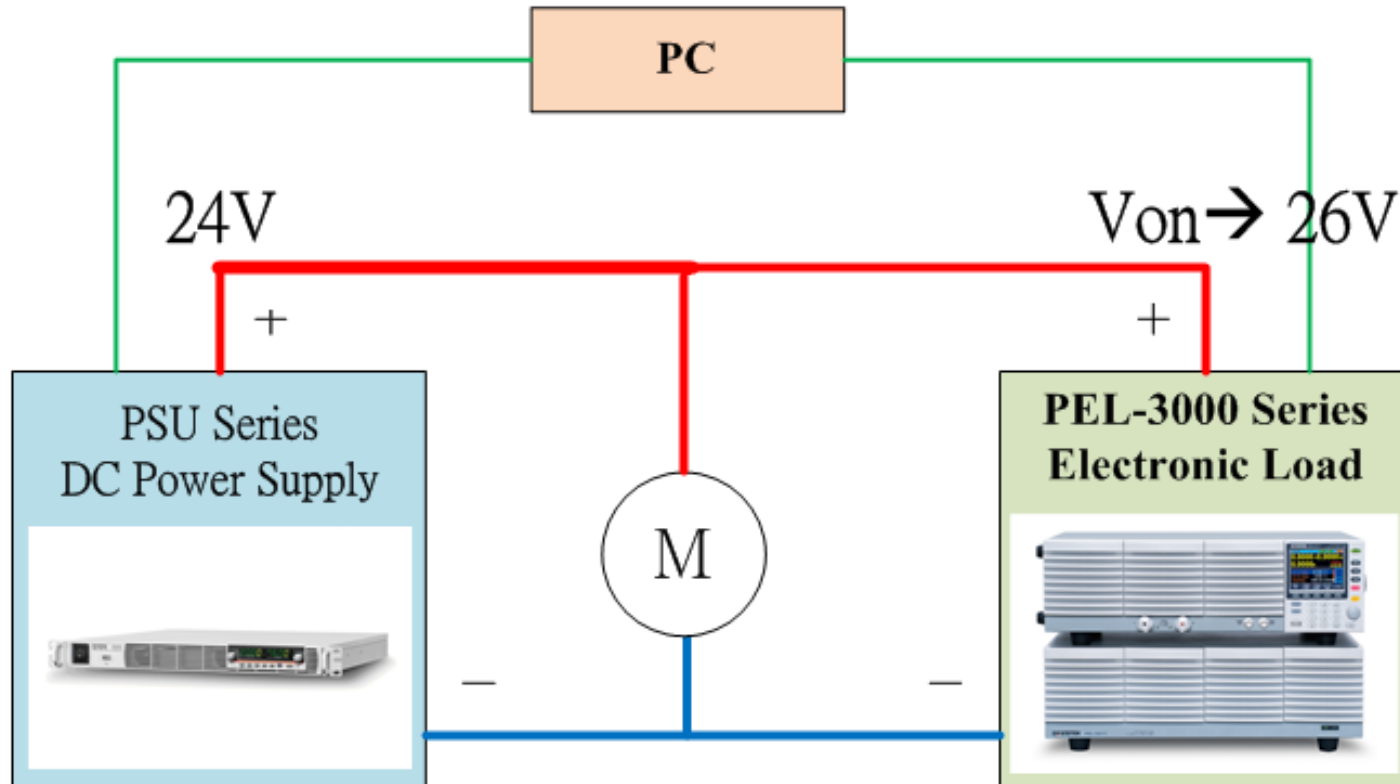
EV/HEV

- Battery Charge / Discharge Test



Motors

- Motors Test



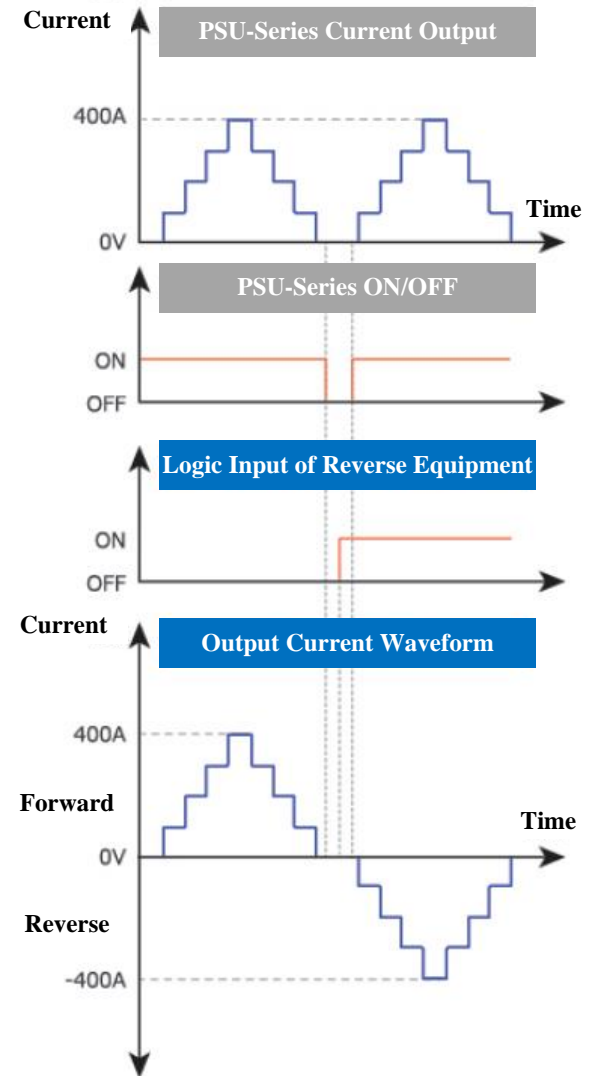
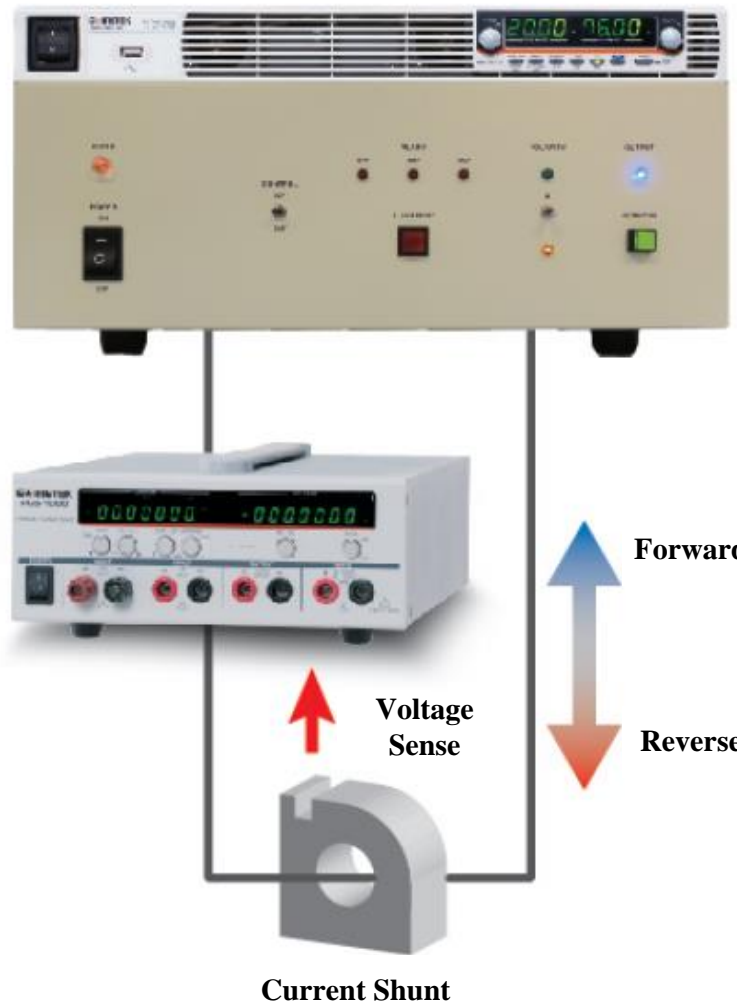
DC load as protection

Current Sensor

High Current DC Power
PSU-Series

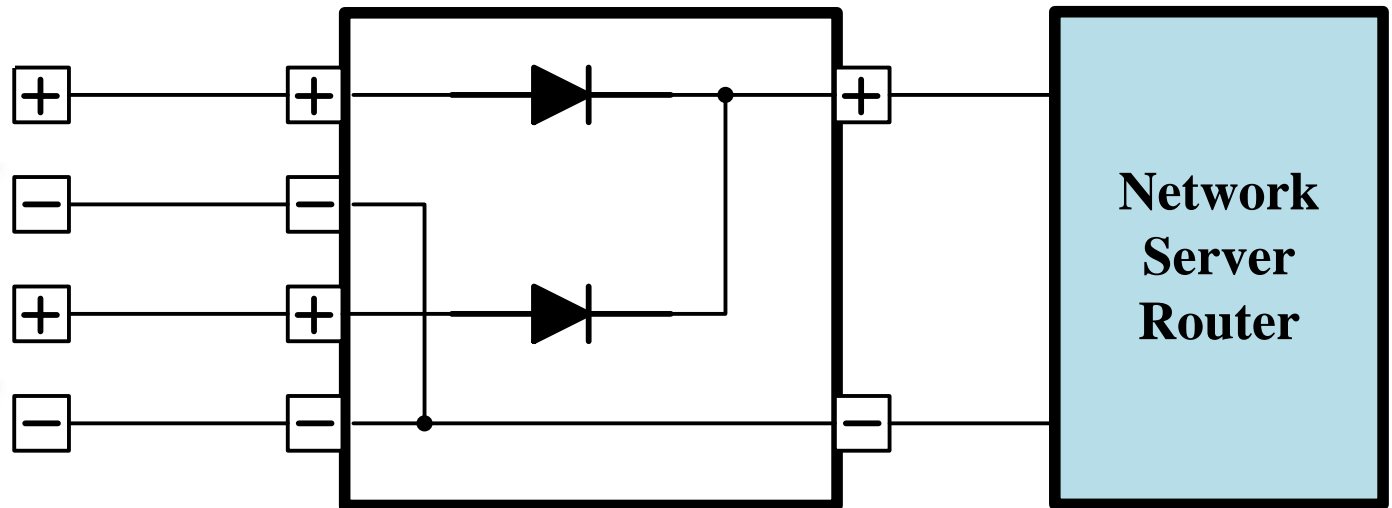
Current Reverse
Equipment

Precision Current Shunt
PCS-1000



Communication server power for network

48V DC Power Source
PSU 60-25



LED Driver Power

Single Phase AC Power Source (500VA – 1kVA)



1P2W, 180Vac-528Vac

LED Driver Power



Aircraft and Aerospace industry

Single Phase AC Power Source (500VA – 3kVA)



1P2W 115Vac/230Vac

400Hz, 360 ~ 800Hz

Electric reclining seat



Lighting for cabin



Open Discussion



Applications for Linear power supplies and Switching Power Supplies.

A list of GW's Power Supplies.

Linear Type



Switching Type

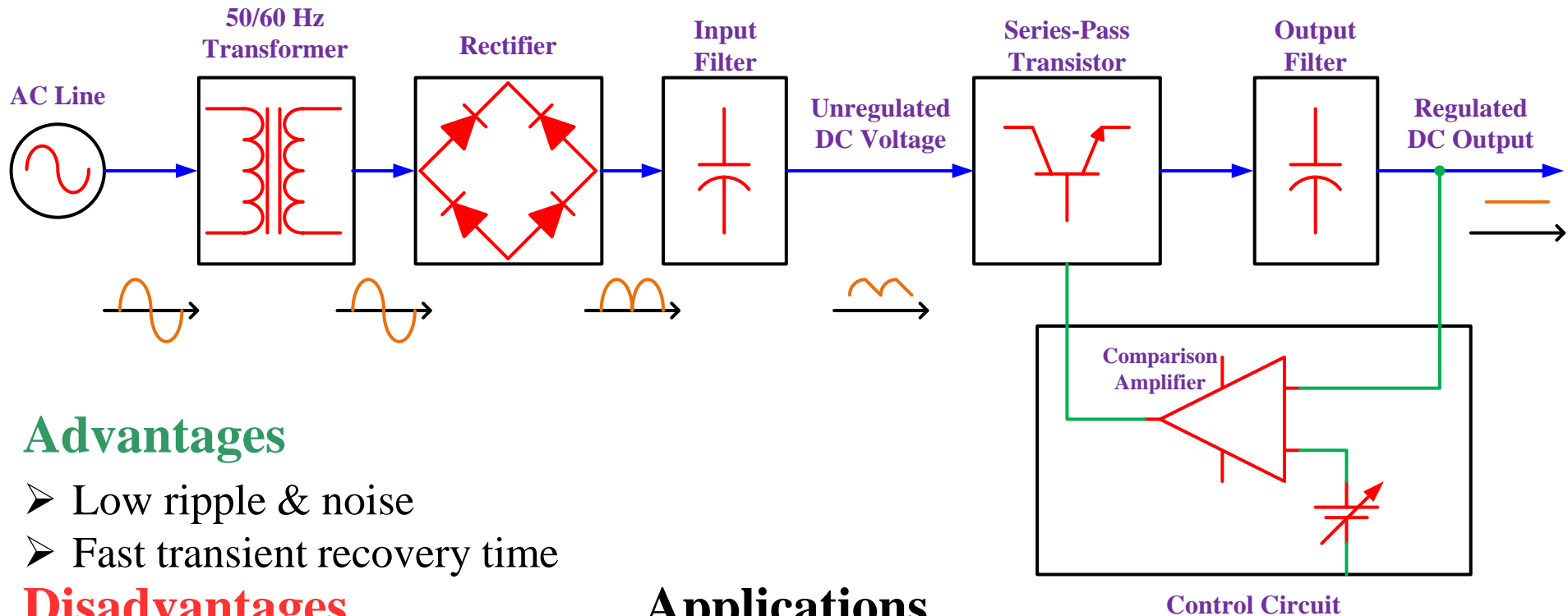


Hybrid Type



Features for Linear Power Supplies.

Linear or series-pass



Advantages

- Low ripple & noise
- Fast transient recovery time

Disadvantages

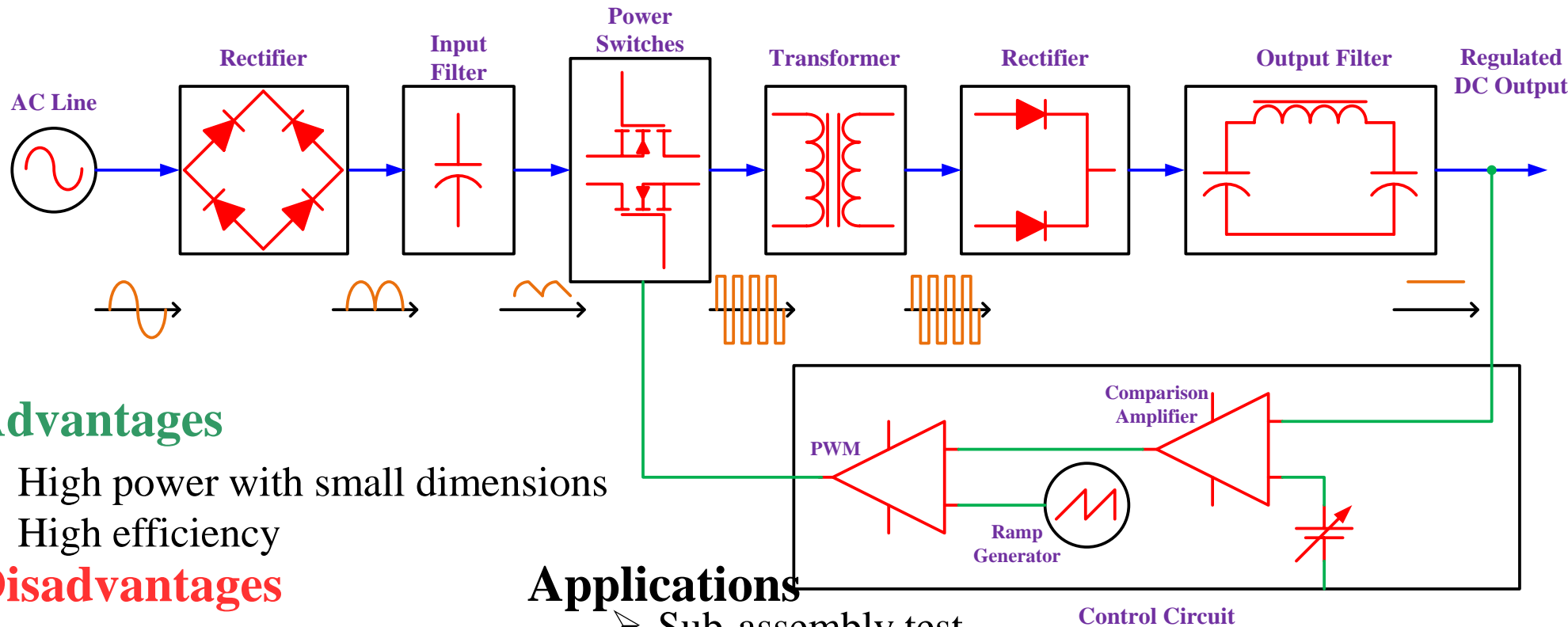
- Low efficiency
- Heavy weight for High watts
- Bulky

Applications

- Bench & laboratory
- Automated test
- Low power: $\leq 500\text{ W}$

Features for Switching mode Power Supplies.

Switched mode (SMPS)



Advantages

- High power with small dimensions
- High efficiency

Disadvantages

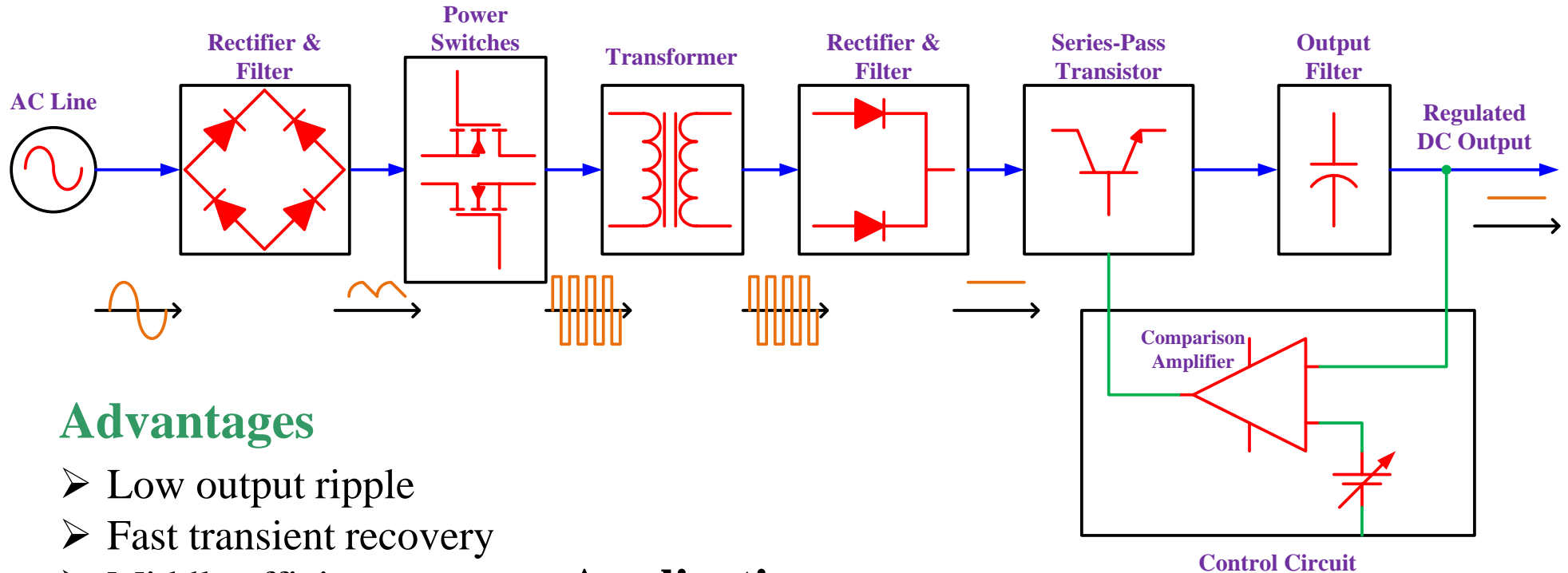
- Moderate ~ high ripple & noise
- Moderate transient recovery

Applications

- Sub-assembly test
- Burn-in
- Bench & laboratory
- Motor test

Features for Hybrid(Switching + Linear) Power Supplies.

Hybrid (Switching + Linear)



Advantages

- Low output ripple
- Fast transient recovery
- Middle efficiency

Disadvantages

- High cost

Applications

- Bench & laboratory
- Automated test
- Middle power: $\leq 1000\text{ W}$

Features for Linear power supplies and Switching mode Power Supplies.

	Advantages	Disadvantages
Linear DC power supply	<ul style="list-style-type: none"> • Fast transient response • Low ripple & noise • Cost competitive at lower output power levels (<500W) 	<ul style="list-style-type: none"> • Low efficiency • Large dimensions and weight • High cost at high power (>500W)
Switching DC power supply	<ul style="list-style-type: none"> • High Power conversion efficiency • Small size and light weight • Cost effectiveness, especially at high power. 	<ul style="list-style-type: none"> • High ripple & noise • Slow transient response
Hybrid DC power supply	<ul style="list-style-type: none"> • High power conversion efficiency • Small size and light weight • Fast transient response • Low ripple voltage and current 	<ul style="list-style-type: none"> • High cost

Applications for Linear power supplies and Switching mode Power Supplies.

Which DC Power Supply Should I Choose ?

	Who are our potential users?
Linear DC Power supply	<ul style="list-style-type: none"> • Prefer Low Line Regulation and Load regulation • Care about the Ripple & Noise of power supply • Prefer the fast transient response of the power output
Switching DC Power supply	<ul style="list-style-type: none"> • Concern the power efficiency, energy saving and burn-In • Prefer small size or light weight
Hybrid DC Power supply	<ul style="list-style-type: none"> • Concern small size, light weight and low Ripple & Noise • Concern small size, light weight and fast transient response • price-insensitive

How to select cheaper Power supplies

What are the differences between GWInstek GPE series Power supply and competitors' power supplies ?

How to select cheaper Power supplies

- Specifications comparison
- Functions comparison
- The key parts quality analysis (Transformer/Relay / Capacitor/ LCD/VR/Fan / wire / PCB ..,etc.)
- Summary

Specifications comparison

		GPE-3323	GPS-3303	Other Brand
Output Voltage/Current	CH1/CH2	0~ 32.00V , 0~3.000A	0~30.0V, 0~3.00A	0~32.0V, 0~3.00A
	CH3	5V, 5A	5V,3A	3~6.0V ,3A
Constant Voltage Operation	Regulation	Line regulation $\leq 0.01\%+3\text{mV}$	Line regulation $\leq 0.01\%+3\text{mV}$	Line regulation $\leq 0.01\%+3\text{mV}$
		Load regulation $\leq 0.01\%+3\text{mV}$	Load regulation $\leq 0.01\%+3\text{mV}$	Load regulation $\leq 0.01\%+5\text{mV}$
	Ripple & Noise	Ripple&Noise $\leq 1\text{mVrms}$	Ripple&Noise $\leq 1\text{mVrms}$	Ripple&Noise $\leq 1\text{mVrms}$
	Recovery Time	$\leq 100\mu\text{S}$ (50%Load change, Minimum load 0.5A)	$\leq 100\mu\text{S}$ (50%Load change, Minimum load 0.5A)	$\leq 50\mu\text{S}$ (Over 100uS after actual measurement)
	Temp.Coefficient	$\leq 300\text{ppm} / ^\circ\text{C}$	$\leq 300\text{ppm} / ^\circ\text{C}$	$\leq 0.5\text{mV}+0.05\%$ & $\leq 5\text{mA}+0.5\%$
	Output Range	0 to rating voltage continuously adjustable	0 to rating voltage continuously adjustable	0 to rating voltage continuously adjustable
Constant Current Operation	Regulation	Line regulation $\leq 0.2\%+3\text{mA}$	Line regulation $\leq 0.2\%+3\text{mA}$	Line regulation $\leq 1\%+3\text{mA}$
		Load regulation $\leq 0.2\%+3\text{mA}$	Load regulation $\leq 0.2\%+3\text{mA}$	Load regulation $\leq 1\%+5\text{mA}$
	Ripple Current	$\leq 3\text{mA}_{\text{rms}}$	$\leq 3\text{mA}_{\text{rms}}$	$\leq 3\text{mA}_{\text{rms}}$
	Output Range	0 to rating current continuously adjustable	0 to rating current continuously adjustable	0 to rating current continuously adjustable

Their specifications can't faithfully present their power supply's performances.

Specifications comparison

		GPE-3323	GPS-3303	Other Brand
Output Voltage/Current	CH1/CH2	0~ 32.00V , 0~3.000A	0~30.0V, 0~3.00A	0~32.0V, 0~3.00A
	CH3	5V, 5A	5V,3A	3~6.0V ,3A
Constant Voltage Operation	Recovery Time	≤100μS (50%Load change, Minimum load 0.5A)	≤100μS (50%Load change, Minimum load 0.5A)	≤ 50μS (Over 100uS after actual measurement)
	Temp.Coefficient	≤ 300ppm / °C	≤ 300ppm / °C	≤0.5mV+0.05% & ≤5mA+0.5%
	Output Range	0 to rating voltage continuously adjustable	0 to rating voltage continuously adjustable	0 to rating voltage continuously adjustable

Their specifications can't faithfully present their power supply's performances.

Specifications comparison

		GPE-3323	GPS-3303	Other Brand
Tracking Operation (CH1/CH2)	Regulation of PAR.	Line regulation $\leq 0.01\% + 3\text{mV}$	Line regulation $\leq 0.01\% + 3\text{mV}$??unknown
		Load regulation $\leq 0.01\% + 3\text{mV}$ ($\leq 3\text{A}$)	Load regulation $\leq 0.01\% + 3\text{mV}$ ($\leq 3\text{A}$)	
	Regulation of SER.	Line regulation $\leq 0.01\% + 5\text{mV}$	Line regulation $\leq 0.01\% + 5\text{mV}$	
		Load regulation $\leq 100\text{mV}$	Load regulation $\leq 300\text{mV}$	
		Tracking error $\leq 0.1\% + 10\text{mV}$ (0~32V) (No load, with load add load regulation $\leq 100\text{mV}$)	Tracking error $\leq 0.5\% + 10\text{mV}$ (0~30V) (No load, with load add load regulation $\leq 300\text{mV}$)	
Meter	Display	4.3" monochrome LCD	4 sets 3 digits 0.5" LED	4 sets 3 digits 0.5" LED
	Resolution	Voltage: 10mV (0~33.00V)	Voltage: 100mV (0~32.0V)	Voltage: 100mV (0~33.0V)
		Current: 1mA (0~3.200A)	Current: 10mA (0~3.20A)	Current: 10mA (0~3.20A)
	Readback accuracy ($25 \pm 5^\circ\text{C}$)	Voltage: \pm (0.1% of RDG +2 digit)	Voltage: \pm (0.5% of RDG +2 digits)	Voltage: \pm (1% of RDG +2 digits)
		Current: \pm (0.1% of RDG +2 digit)	Current: \pm (0.5% of RDG +2 digits)	Current: \pm (1% of RDG +2 digits)
CH3	Output Voltage	$5\text{V} \pm 5\%$	$5\text{V} \pm 8\%$	3~ 6V
	Output Current	5A	3A	3A
	Regulation ($25 \pm 5^\circ\text{C}$)	Line regulation $\leq 3\text{mV}$	Line regulation $\leq 5\text{mV}$	Line regulation $\leq 1\%$
		Load regulation $\leq 10\text{mV}$	Load regulation $\leq 15\text{mV}$	Load regulation $\leq 1\%$
	Ripple & Noise	$\leq 2\text{mV}_{\text{rms}}$	$\leq 2\text{mV}_{\text{rms}}$	$\leq 5\text{mV}_{\text{rms}}$

Specifications comparison

		GPE-3323	GPS-3303	Other Brand
Tracking Operation (CH1/CH2)	Regulation of PAR.	Line regulation $\leq 0.01\% + 3\text{mV}$	Line regulation $\leq 0.01\% + 3\text{mV}$??unknown
		Load regulation $\leq 0.01\% + 3\text{mV}$ ($\leq 3\text{A}$)	Load regulation $\leq 0.01\% + 3\text{mV}$ ($\leq 3\text{A}$)	
	Regulation of SER.	Line regulation $\leq 0.01\% + 5\text{mV}$	Line regulation $\leq 0.01\% + 5\text{mV}$	
		Load regulation $\leq 100\text{mV}$	Load regulation $\leq 300\text{mV}$	
		Tracking error $\leq 0.1\% + 10\text{mV}$ (0~32V) (No load, with load add load regulation $\leq 100\text{mV}$)	Tracking error $\leq 0.5\% + 10\text{mV}$ (0~30V) (No load, with load add load regulation $\leq 300\text{mV}$)	

Specifications comparison

Item	Functions	GPE-3323	GPS-3303	Other Brand
1	Display	4.3" monochrome LCD	Four sets 3 digits 0.5" LED	Four sets 3 digits 0.5" LED
2	Protection	OVP	OVP	×
3	AC input	100V/120V/220V AC $\pm 10\%$, 230VAC +10%/-6%	100V/120V/220V AC $\pm 10\%$, 230VAC +10%/-6%	220VAC $\pm 10\%$
4	Fan	Fan Speed control circuit by Temperature	Fan Speed control circuit by Temperature	ON/OFF by Temperature
5	LOCK function	✓	×	×
6	V/I Setting Check	✓	×	×
7	CH3 voltage adjustment	× (GPE-4323 ✓)	×	✓
8	CH1/CH2 Multi-turn potentiometer	×	×	✓
9	CH3 overload	✓	✓	×
10	Tracking operation	✓	✓	✓
11	Designed for safety operation	✓	✓	×

Other Brand can not comply with safety regulations (EMC/LVD...)

Functions comparison

Differences between GPE and other Brands

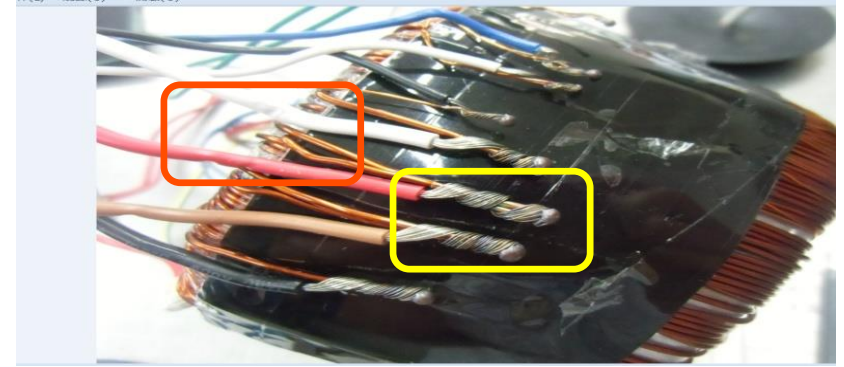
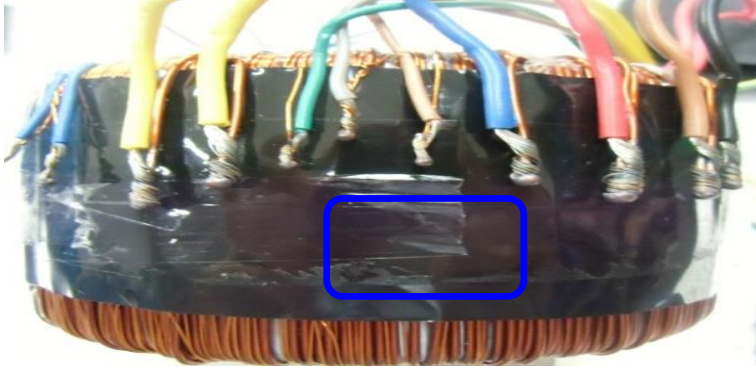
- Although the 95% of circuit structure for 3 channel power supplies are the same, GPE series power supply designs extra smart circuits and protection functions.

	Others Brand	GW
Fan Control	Fan control only two state(ON/OFF)	An additional temperature detection circuit and loop control for Fan speed
Over load protection	No over load protection for Ch3	Added Over load protection circuit for Ch3
OVP function	No OVP	Over Voltage Protection for all channels

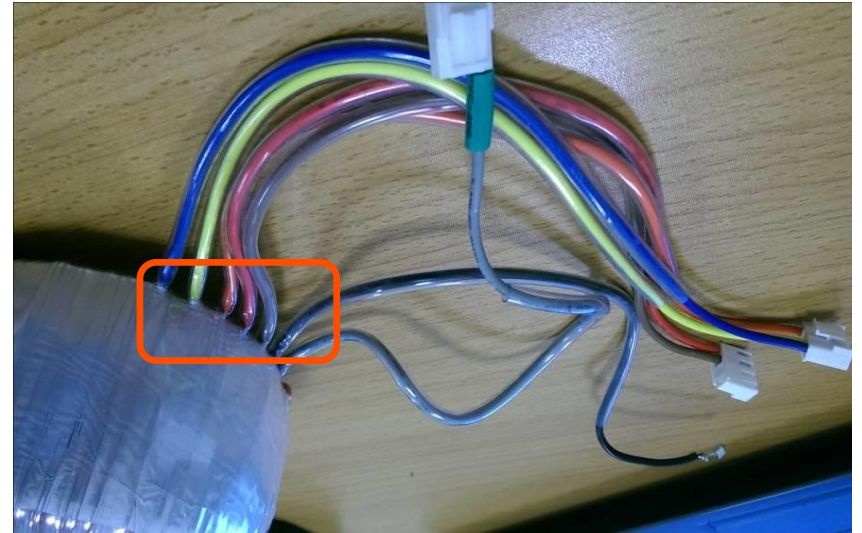
- What else?? **The materials are quite different** between GPE and other Brands. Such as the Transformer ,Heat sink ,Capacitor ,Fan ,Relay ,Wire ,PCB. . key material. Other brands focus on keeping cost down and ignore their qualities.

The key parts quality analysis (Transformer)

Other
Brand



GWInstek



The key parts quality analysis (Transformer)

	Other Brand	GWInstek	Remarks
Output Power	400.25W	404.1W	GPE为376.32W
core grade	H grade	Z grade	The temperature of H grade is rising faster than that of Z grade (The reliability of H grade is worse for long-term operation of power supply)
Copper wire diameter size	IN : 0.8mm OUT : 1.20mm/0.45mm	IN : 0.85mm OUT : 1.30mm/0.55mm	Under the same current, the rising rate of temperature is faster for smaller diameter copper wire. (The high temperature is worse for long-term operation of power supply)
Thermal fuse	NA	108 degree	Other brands' thermal fuses are not complying with safety certification (may cause to burned out)
Materials for insulation	Adhesive tape	According to the safety certification requirement.	The internal insulated materials of Other brands are not complying with safety certification (may cause to burned out)
Input / Output Wire	No double layer Insulation	According to the safety regulation requirements.	Other brands are not complying with safety certification (may cause to burned out)
Cost (US\$)	23	31	

Other brands are not complying with safety regulations. (Safety is a great concern)

The key parts quality analysis(Capacitor)

	Other Brand	GWInstek	Remarks
Cap. Brand	?	Jamicon	
SPEC.	CH1/CH2: 4700u/63v	CH1/CH2: 4700u/63v	
Cost(US\$)	0.44	0.85	
Safety	No	According to the safety certification requirement.	

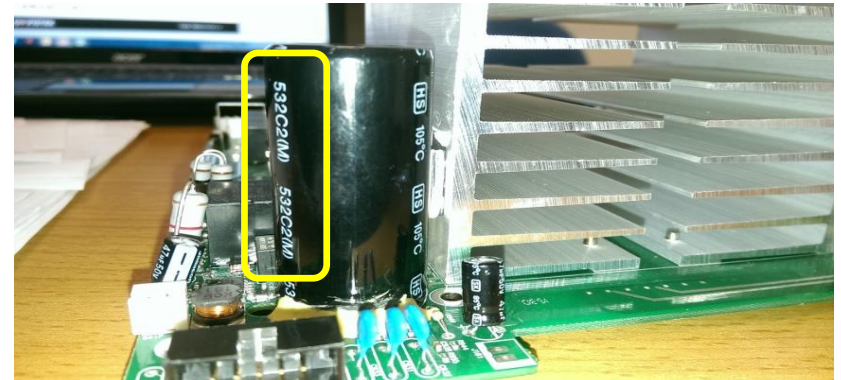
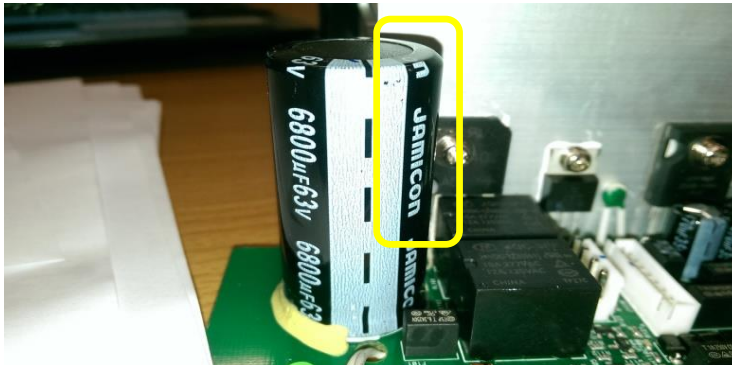
The Capacitor have no any information about factory and Safety certification number.

The key parts quality analysis (Capacitor)

Other
Brand

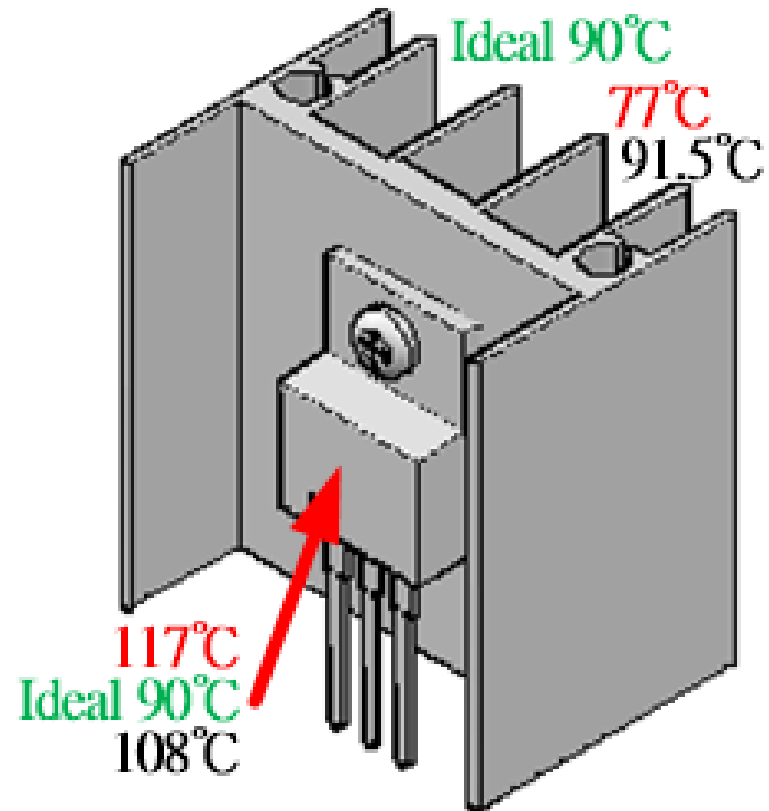


GWInstek



The key parts quality analysis (HeatSink)

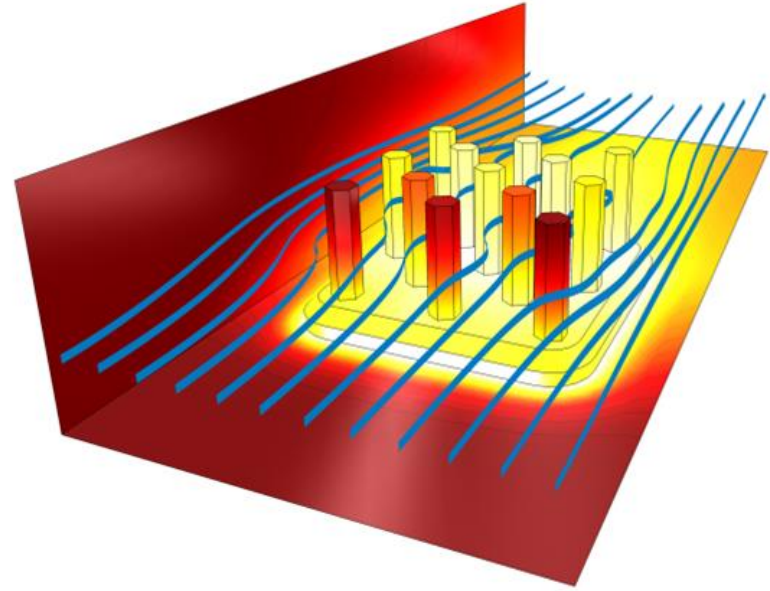
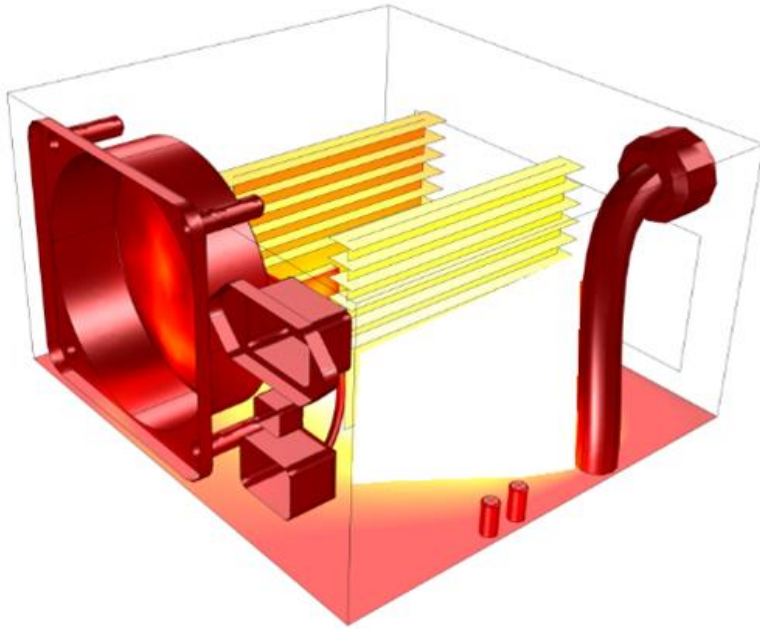
- The purpose of the Heatsink helps to dissipate the power transistor temperature.
- The heat-conduction capability of HeatSink of Other Brands are worse than GWInstek.
(The Power transistors of Other Brands are damaged by testing in the ambient temperature of 45 °C)



The key parts quality analysis (HeatSink)

	Other Brand	GWInstek
Brand	?	Material:3060
Volume	$36.10 \times 65.06 \times 79.11$	$80.08 \times 40.10 \times 70.90$
Weight	0.383kg	0.468kg
Temperature	77°C (Transistor 117°C)	91.5°C (Transistor 108°C)
Temperature difference	40°C (117-77)	16.5°C (108-91.5)

The key parts quality analysis(Fan)



Fans help air flow to reduce the interior temperature of Power supplies.

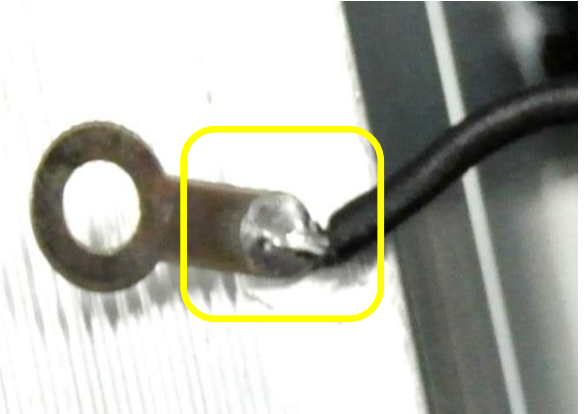
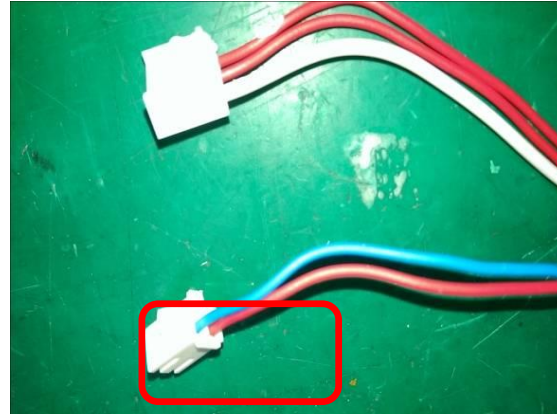
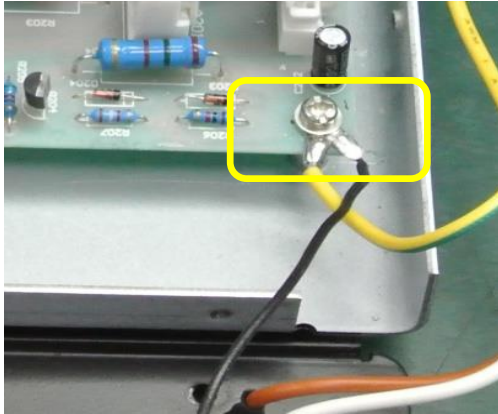
The key parts quality analysis(Fan)

	Other Brand	GWInstek
Brand	“qi fang”	Electrical Core & Motor Manufacturing Ltd.
Bearing	Carbon brush	Ball Screw (Bearing form Japan NMB)
Safety	No	According to the safety certification requirement.
Cost	-	68% higher

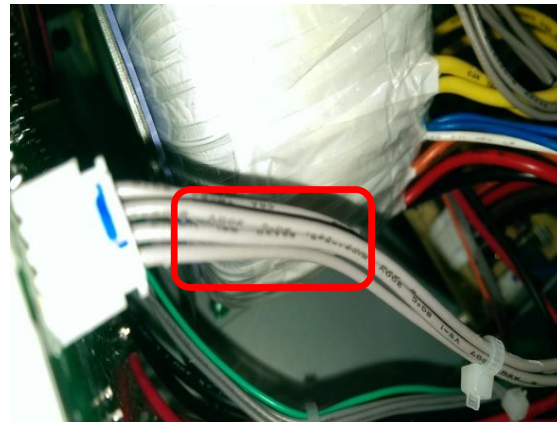
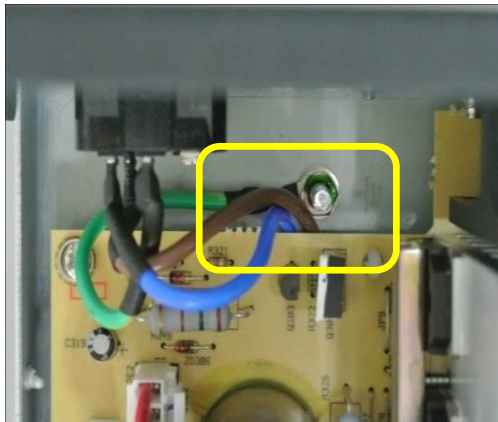
Carbon brush is more easily damaged by wear and tear than Ball Screw.

The key parts quality analysis(Wire)

Other
Brand



GWInstek

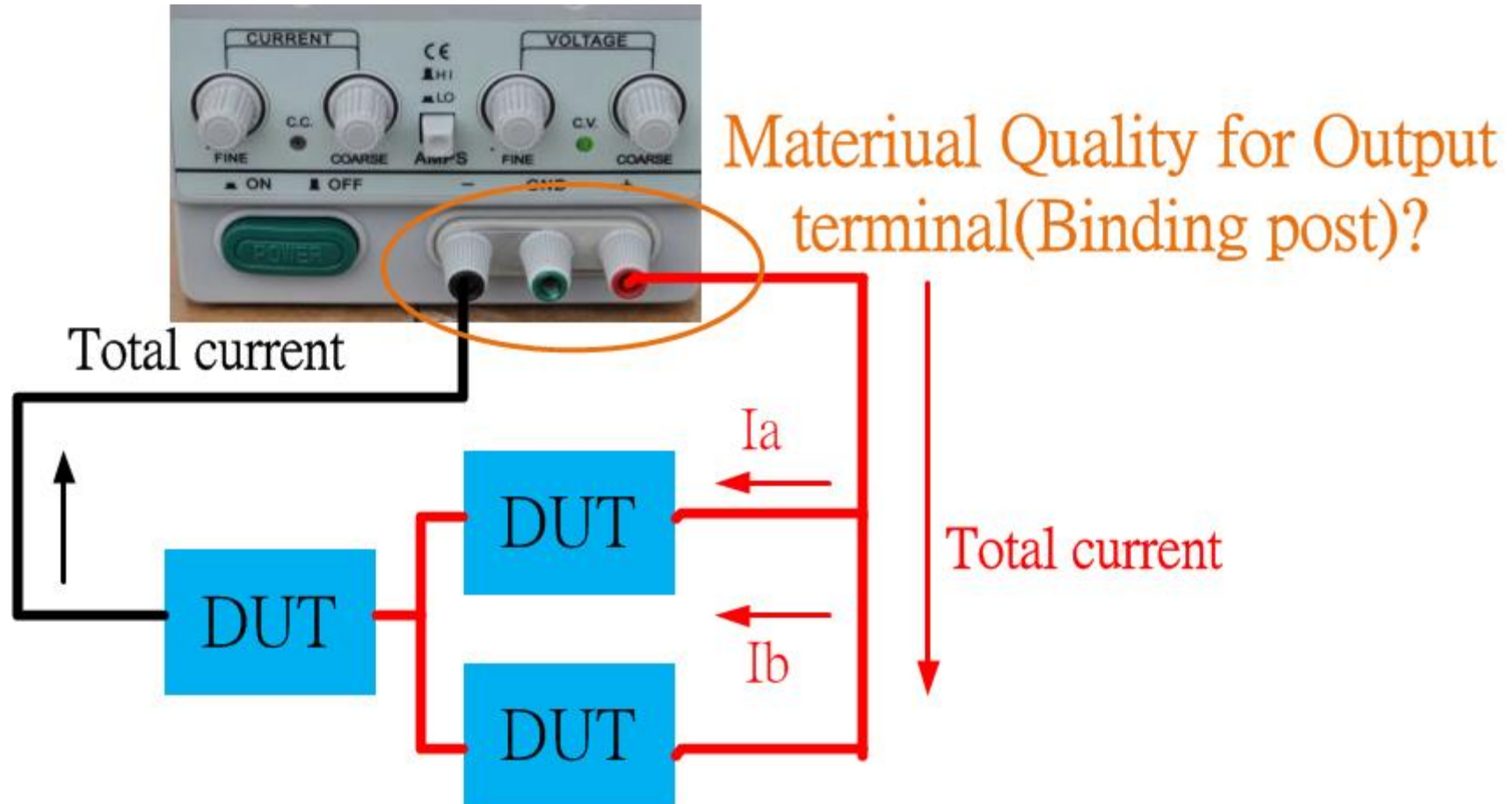


The key parts quality analysis(Wire)


	Other Brand	GWInstek	Remarks
AC input	The wire without model no.and safety certification (Diameter size 2.2mm)	Standard wire type and safety certification (Diameter size 2.5mm)	Other brand is small diameter size, No secondary insulation. It's not in conformity with international usage.
GND	The wire without model no.and safety certification (Diameter size 1.3mm)	Standard wire type and safety certification (Diameter size 3.1mm)	Other brand is small diameter size.It's not in conformity with international usage.
Other Wires	The wire without model no.and safety certification	Standard wire type and safety certification	Other brand is small diameter size.It's not in conformity with international usage.

Regarding wire type, safety regulations are not in conformity with international usage.

The key parts quality analysis (Output terminals)



The key parts quality analysis (Output terminals)

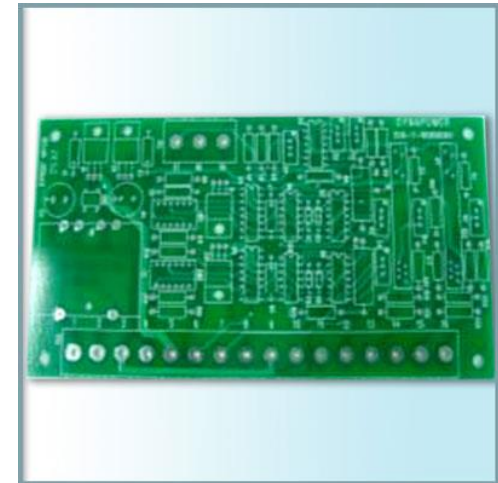
	Other Brand	GWInstek	Remarks
Safety certification	The metal part is not pure copper (Lead and copper compound) and the diameter size is smaller than GW over 1mm. The plastic part has not added fire-retardant and resisted UV characteristic.	The metal part is 59 copper. The plastic part has added fire-retardant and resisted UV characteristic. 	
Cost(US\$)	0.27	0.65	7 pcs/Unit

Other brands can't pass any safety certification. (Safety is a great concern)

The key parts quality analysis(PCB)

	Other Brand	GWINSTEK
PCB Manufacturer	Unknown	Compeq Manufacturing Co., Ltd
Cost(US\$)	4.2(without fireproofing mark)	5.75
Safety certification	NO fireproofing mark.(No any safety certification)	Fireproofing mark.(Safety certification)

Other brands can't pass any safety certification. (Safety is a great concern)



The key parts quality analysis (Front Frame/Knob)

	Other Brand	GWInstek	Remarks
Front Frame	It is generally ABS material that has not added fire-retardant and resisted UV characteristic (US\$2/kg).	It is PA764 ABS material that has added fire-retardant and resisted UV characteristic.(US\$4.15/kg).	
Cost	-	30% higher	
Knob	Same as above	Same as above	
Cost(US\$)	0.03	0.074	7 pcs/Unit

Other brands can't pass any safety certification. (Safety is a great concern)

Summary

- The specifications of other brands can't faithfully present their power supply's performances.
 - Suggest to actually measure the key specifications

- The other brands' design are not enough for safety considerations. Their power supplies are possibly a short lifetime, worse reliability and even brings dangerous.
 - Suggest to select the vendors which designs power supplies for many years.

Summary

- The most of materials of other brands come from unknown vendors and aren't conformity with safety regulations.
 - ➔ Suggest to select the power supply from vendors with good reputations in market.
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- Other brands pursue cost down to sacrifice the safety and ignore regulations.
 - ➔ It would take more money if you really happen to Safety issues.

Thanks for your consideration !