Source Measure Unit Application Handbook

QUALITY ■ INNOVATION ■ FORESIGHT

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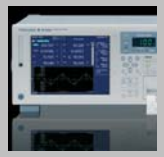


GS610
Source Measure Unit
Application Handbook

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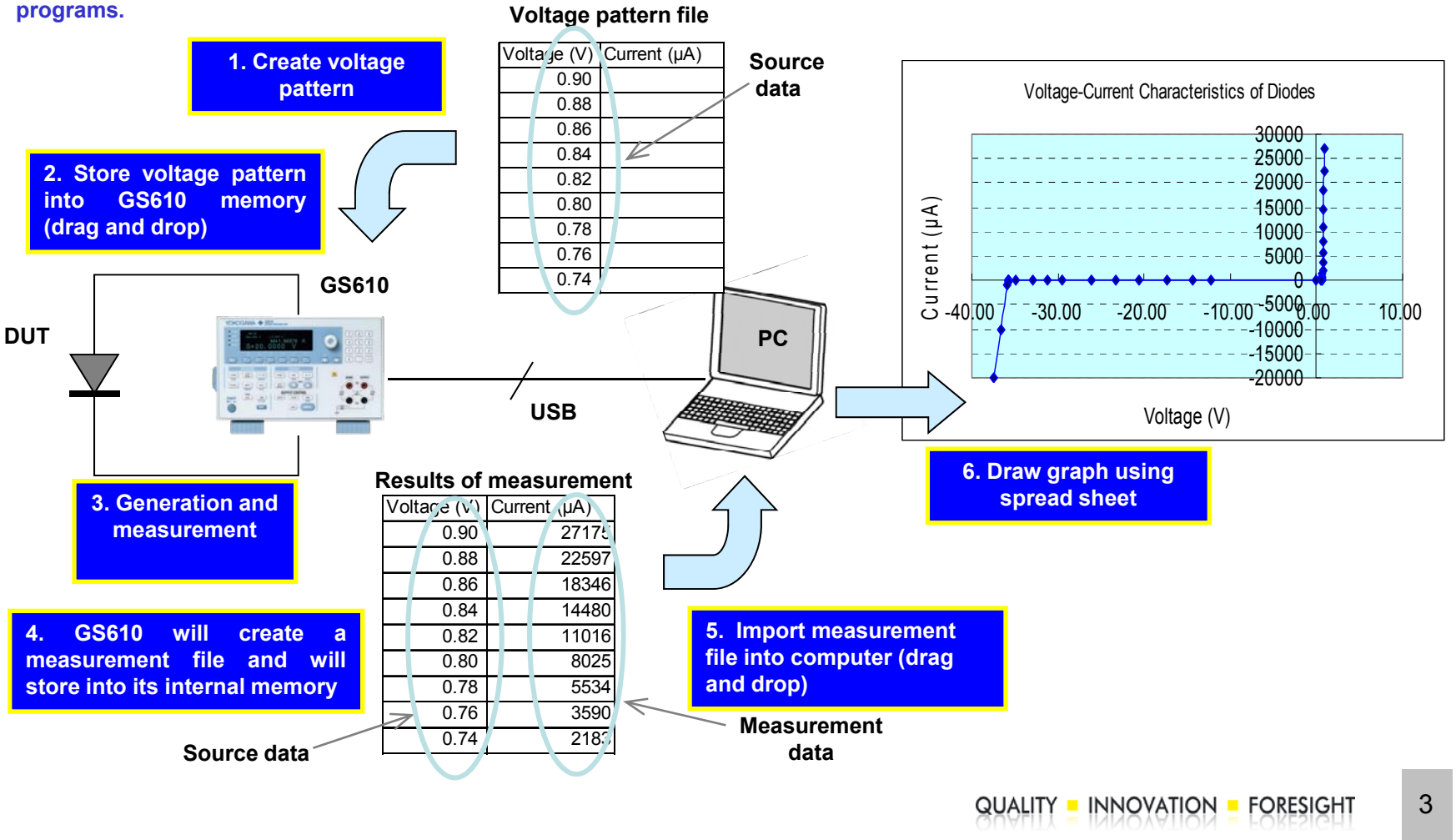
Measuring Static Characteristics of 2-terminal Semiconductor Devices

Application

GS610 can measure the V-I characteristics of 2-terminal semiconductor devices such as diode, thermistor and varistor. Use the curve tracer function in GS610 to capture the V-I characteristic data and to draw the graph on the spread sheet. This requires absolutely no cumbersome programming or installation of dedicated software programs.

Solution Features

- Curve tracer function with multipurpose work sheets
- Less expensive than curve tracers (about one forth the price)
- Curve tracer with max 110 V and max 3.2A
- Basic voltage accuracy is ±0.02% and basic current accuracy is ±0.03%
- No control software needed



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Measuring Static Characteristics of 3-terminal Semiconductor Devices

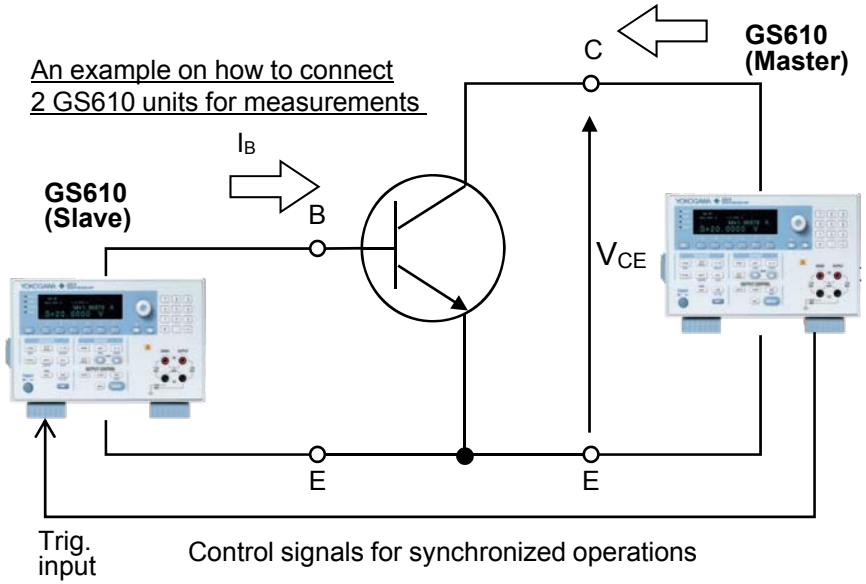
Application

Two GS610s are operated in sync to measure the static characteristics of a transistor. Constant h is then determined from the slope of each characteristics data. In the I_B-I_C characteristics measurement, a GS610 for base current I_B output and a GS610 for collector current I_C measurement are operated in sync to measure the characteristics. The V_{CE}-I_C characteristics measurement is possible by connecting one GS610 to another GS610 between the emitter and the collector, applying V_{CE}, and measuring the collector current I_C.

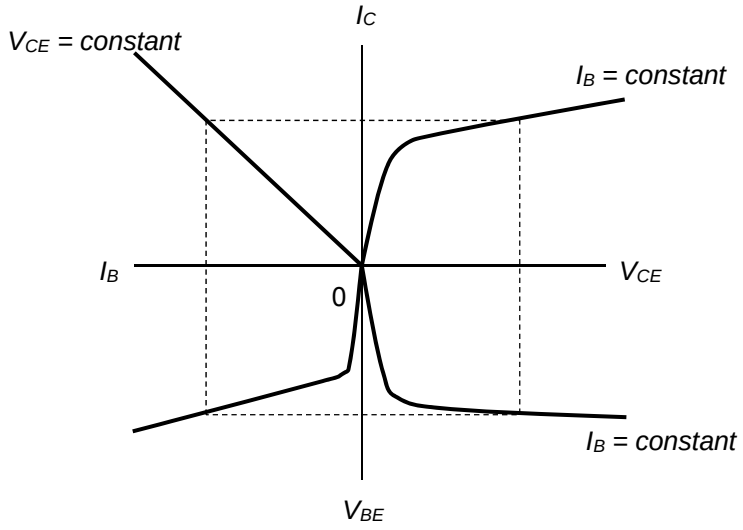
Solution Features

- **Curve tracer function with multipurpose work sheets**
- **Less expensive than curve tracers (about one forth the price)**
- **Curve tracer with max 110V and max 3.2A**
- **Basic voltage accuracy is ±0.02% and basic current accuracy is ±0.03%**
- **No control software needed**
- **Easy to connect, easy to set up when operating multiple units in sync**

An example on how to connect
2 GS610 units for measurements



V-I Characteristics of Transistor



- V_{CE}-I_C characteristics (h_{oe})
- I_B-I_C characteristics (h_{fe})
- V_{BE}-I_B characteristics (h_{ie})
- V_{CE}-V_{BE} characteristics (h_{re})

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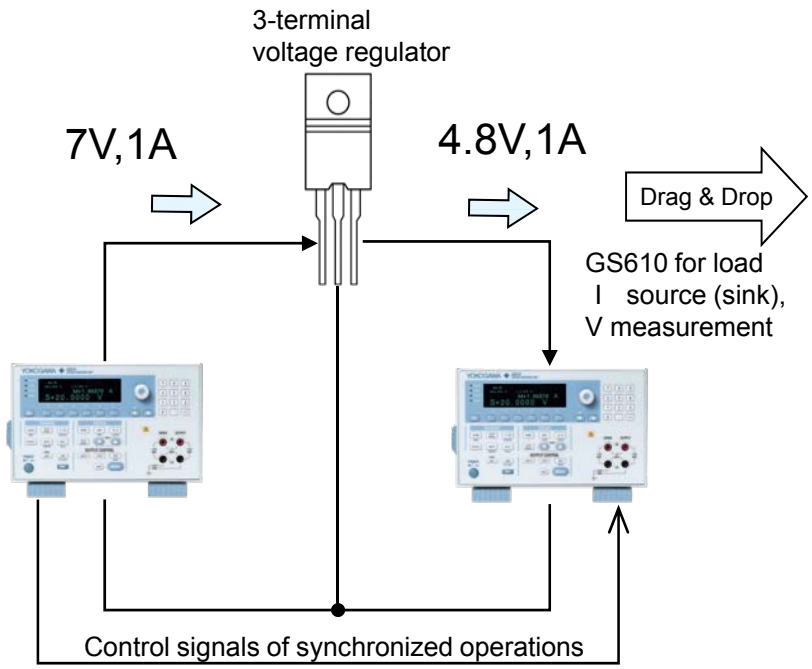
Measuring Power Efficiency of Power Source Devices

Application

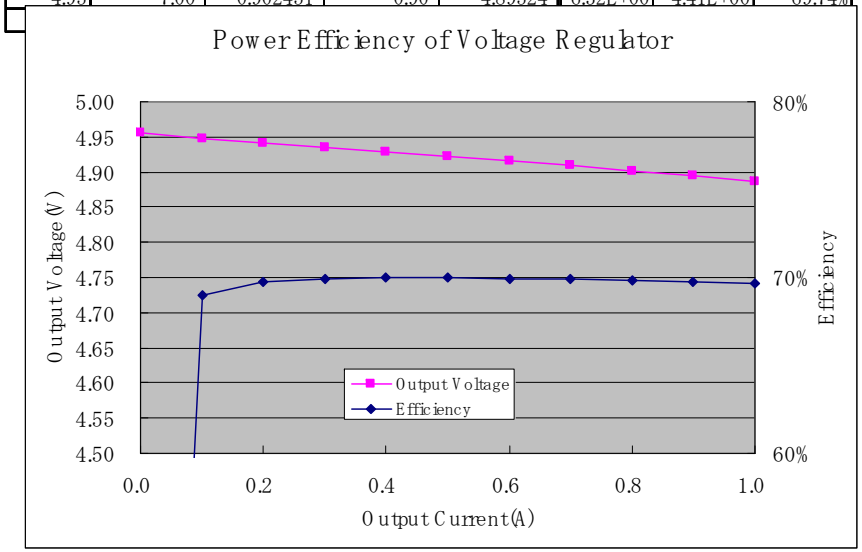
GS610 can measure the efficiency of power conversion of power source devices such as 3-terminal voltage regulators and DC-DC converters. GS610 that provides power will supply the voltage to regulator's input and measure the current as well. GS610 that works as an electronic load consumes current from regulator's output and measure the output voltage. The efficiency of power conversion can be calculated as a ratio between provided power and consumed power.



Solution Features

- Power provision and power consumption (load)
- Can generate and measure max 110V and max 3.2A
- Collection of measurement data and power conversion efficiency calculation using multipurpose worksheets
- No control software needed
- Easy to connect, easy to set up when operating multiple units in sync

Time(s)	Source(V)	Measure(A)	Source(A)	Measure(V)	Input(W)	Output(W)	Efficiency
0	7.00	0.002617	0.00	4.95495	1.83E-02	0.00E+00	0.00%
0.55	7.00	0.102457	-0.10	4.94771	7.17E-01	4.95E-01	68.99%
1.1	7.00	0.202470	-0.20	4.94113	1.42E+00	9.88E-01	69.73%
1.65	7.00	0.302443	-0.30	4.93466	2.12E+00	1.48E+00	69.93%
2.2	7.00	0.402436	-0.40	4.92822	2.82E+00	1.97E+00	69.98%
2.75	7.00	0.502437	-0.50	4.92177	3.52E+00	2.46E+00	69.97%
3.3	7.00	0.602380	-0.60	4.91529	4.22E+00	2.95E+00	69.94%
3.85	7.00	0.702407	-0.70	4.90882	4.92E+00	3.44E+00	69.89%
4.4	7.00	0.802434	-0.80	4.90221	5.62E+00	3.92E+00	69.82%
4.95	7.00	0.902451	-0.90	4.89524	6.32E+00	4.41E+00	69.74%



Checking Malfunctions in Electronic Circuits with Power Voltage Fluctuation

Application

Check the operation limits in voltage level and pulse width by applying glitches to the electronic circuit with power voltage fluctuations. GS610 Source Measure Unit is a programmable highly precise voltage current generator which can easily program the power voltage fluctuations of voltage reduction, excessive voltage, start ups and such. Can provide programmable power up to max 110V and 3.2A.

Vcc (V)
3.30
3.30
3.30
3.30
3.30
2.50
3.30
3.3
3.3
3.3
3.30

Drug & Drop

Instantaneous voltage drop

Vcc

Power supply voltage Vcc →

Electronic Circuit

GS610 Source Measure Unit

Solution Features

- **Generates power voltage fluctuations of voltage reduction, excessive voltage, start ups and such.**
- **Program output per max speed of 100µsec**
- **Easy file operations using built-in USB memory**
- **Can generate multi-power simulations using a number of units in sync**

Waveforms during normal operations

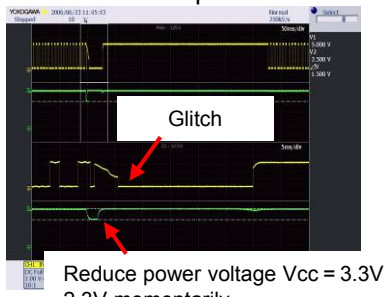
Logic signal

Power line

Logic signal (Zoom)

Power line (Zoom)

Waveforms during abnormal operations



Reduce power voltage Vcc = 3.3V to 2.3V momentarily
(pulse width ≒2m s)

Signal Analysis

DL9240 Digital Oscilloscope

Our digital oscilloscope DL9000 series with high speed sampling, long memory, and zoom functions is best to analyze waveforms during malfunctions.

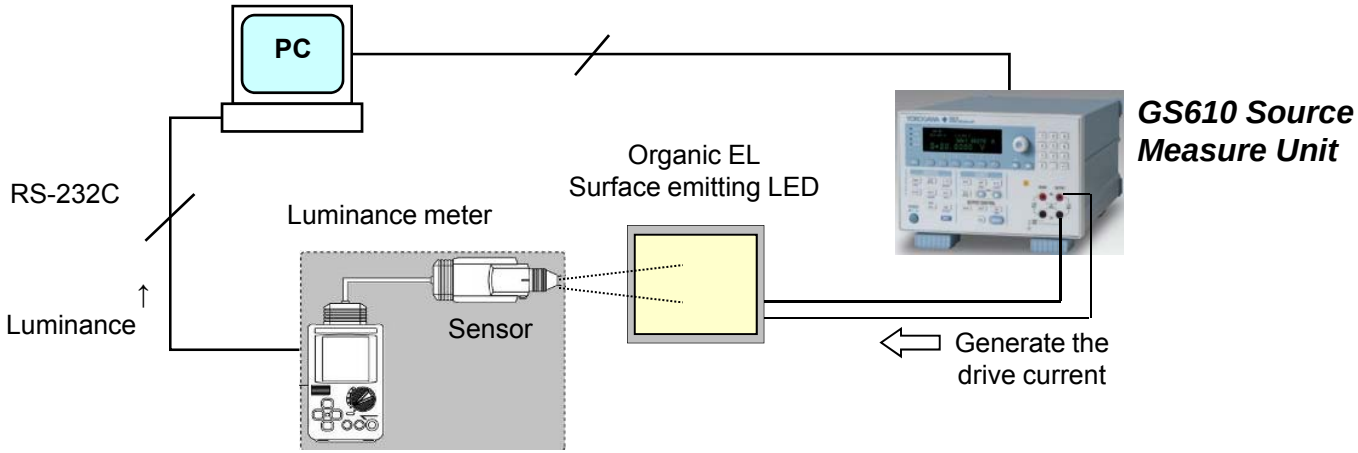
Measuring Emission Efficiency of Organic EL and LED

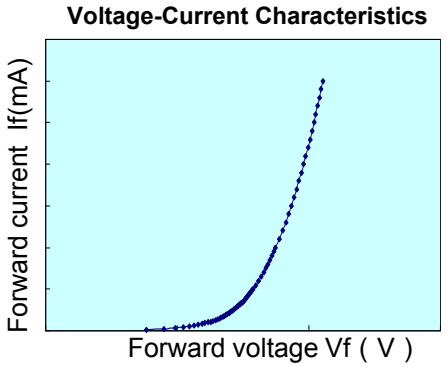
Application

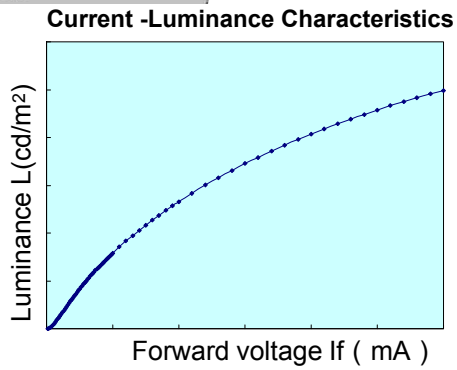
GS610 can be used to drive flat panel displays such as organic EL displays and surface emitting LEDs. The voltage-current characteristics and current-luminance characteristics of the display are measured using GS610 and a luminance meter. From the measurement results, the operating point that maximizes the luminous efficiency (luminance and power consumption) is determined.

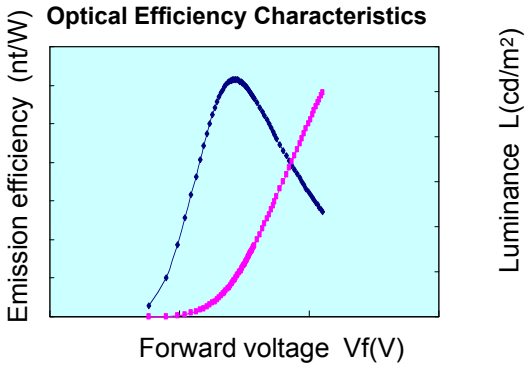
Solution Features

- DC and pulse current drive is possible
- Basic current accuracy of ±0.03%
- Compact and an affordable system
- Matrix drive by operating multiple units in sync





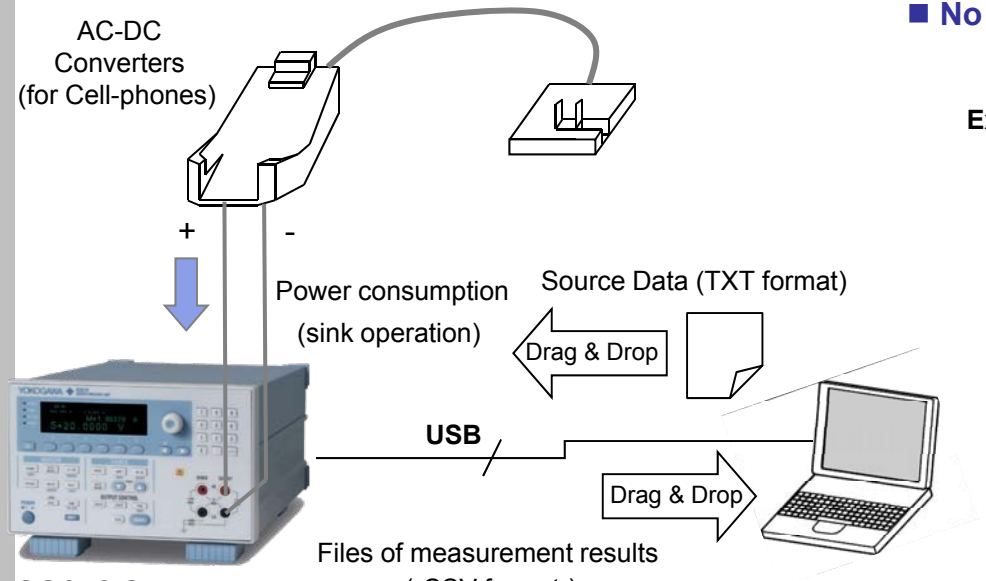




Measuring Dropping Characteristics of AC-DC Converters

Application

GS610 can measure output characteristics of AC adapters for mobile phones. Although it is generally known that power dropping characteristics consists of constant current types and fold-back types, GS610 carries out constant current and constant voltage sink operations as an AC adaptor load to curve trace the dropping characteristics.



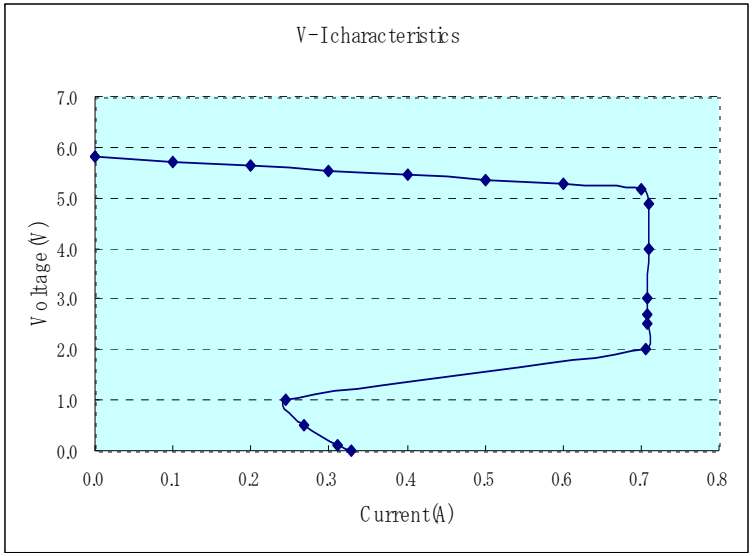
GS610 Source Measure Unit

Source (A)	Measure (V)
0.00000	5.81359
−0.10000	5.71065
−0.20000	5.62070
−0.30000	5.53124
−0.40000	5.44060
−0.50000	5.34990
−0.60000	5.25922
−0.70000	5.16901

Solution Features

- Can curve trace at max 110V and max 3.2A
- Can automatically switch from I source V measure to V source I measure (automatic VI function)
- Basic voltage accuracy ±0.02%, basic current accuracy ±0.03%
- Data collection and graph drawing using multipurpose worksheet
- No control software needed

Examples of drooping characteristics of AC-DC converters



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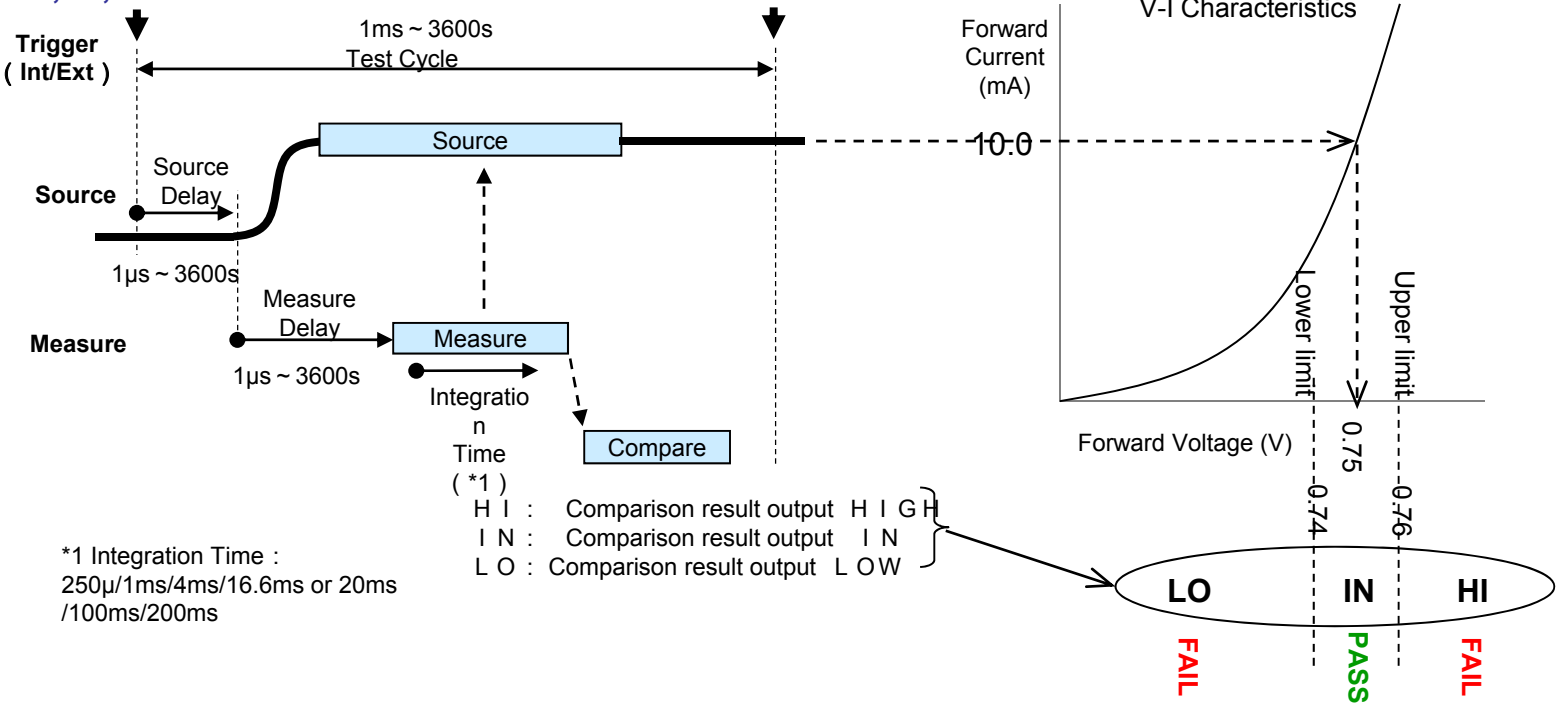
Go / No-Go Judgment Test Using Comparator Function

Application

GS610 can synchronize source, measure, and compare in each operation mode as shown below. With the trigger as the base point, measurement initiates after the source delay time passes. When the measure delay time passes, the time until the source level is stable, measurements are made during the set integral time. When the source and measure is completed during one test cycle, the upper and lower value of the measurement results are compared to read out the judgment results such as HIGH, IN, and LOW.

Solution Features

- Source, measure, and compare operates in sync.
- Reads out comparative judgment results as HI, IN, and LO.
- Can change the judgment criterion in real time.
- High speed test cycle per max speed 1ms.
- Can easily carry out Go/No-Go judgment test at production lines.



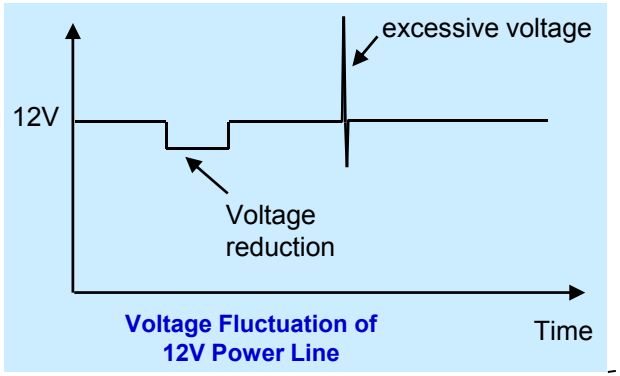
Voltage Fluctuation Simulation of Electronic Devices and Sensors for Vehicles

Application

The power supply of automobiles (12 V or 24 V) fluctuates greatly with voltage reduction, superimposed excessive voltage, etc. The USB storage function of the GS610 enables waveform data of voltage fluctuation to be easily acquired and read out. The supply voltage fluctuation in the actual automobile can be reproduced in the laboratory for testing, which eliminates the need to install the device under test in the automobile. In addition, by capturing the supply voltage fluctuation waveform with a digital oscilloscope and storing the waveform data in the GS610 internal memory, the actual supply voltage fluctuation waveform can be easily reproduced.

Solution Features

- Can make programs of voltage reduction, excessive voltage and such
- Waveform data descriptions using multipurpose worksheets
- Program output per max speed of 100µsec
- Easy filing operations using built-in USB memory
- Can import and replay actual waveforms



Voltage Fluctuation of 12V Power Line

Voltage (V)
12.00
12.00
:
10.80
10.80
:
12.00
30.50
11.50
:
12.00
12.00

Voltage reduction

Excessive voltage

Waveform data (CSV)

Capture the fluctuation waveform (Sampling rate: 10ks/S)

Waveform data (CSV)

Drag & Drop

PC

USB

GS610 Source Measure Unit

Device under test (car navigator and other sensors)

Actual waveform data (CSV file)

DL750/750P ScopeCorder

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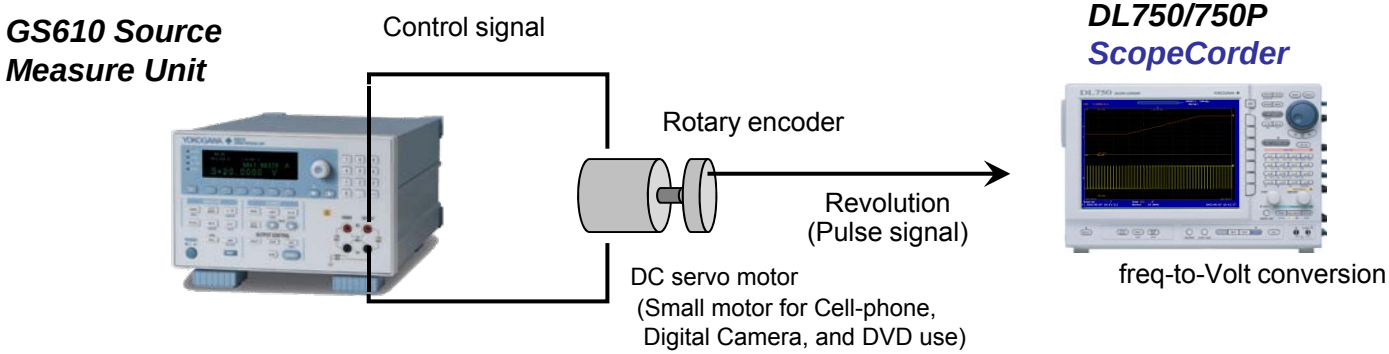
Motor Revolution Characteristics and Response Time

Application

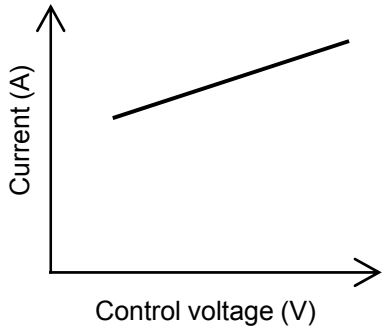
GS610 Source Measure Unit can control the motor driving voltage and evaluate the linearity of the voltage-revolution characteristics. In addition, electrical and mechanical time constants (response times) can be evaluated by using GS610 Source Measure Unit and DL750 Scopecoder.

Solution Features

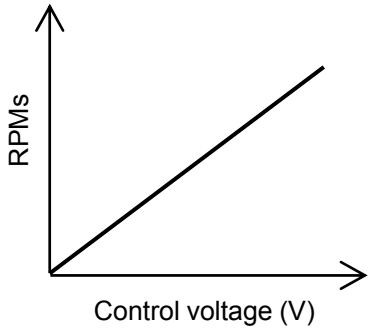
- Can connect GS610 with compact DC motor directly (max current 3.2A)
- Compact and an affordable instrument
- Easy to program control voltage (using multipurpose worksheets)



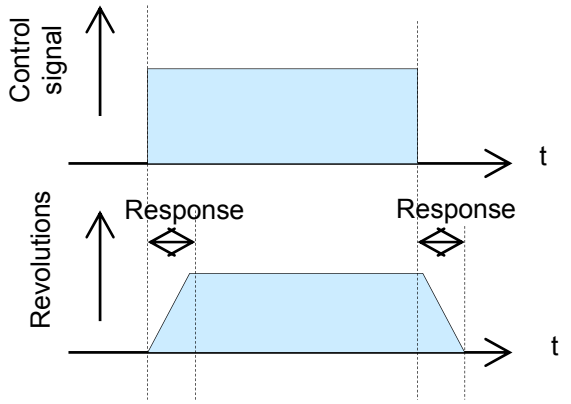
Voltage/Current characteristics



Revolution characteristics



Response Time



Measuring Charge / Discharge Characteristics of Secondary Batteries

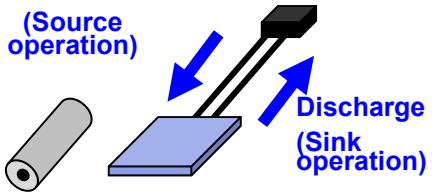
Application

GS610 can be used to simulate the charge/discharge operation of secondary batteries such as lithium-ion and nickel-hydride batteries. In charge operation, current charge is carried out using large current in the range of approximately 2C to 5C (2 to 5 times the battery capacity). When the battery voltage reaches a given value, a switch is made to constant voltage operation. In constant voltage charge operation, the charge current gradually decreases. When it decreases to a given value, the charge operation is stopped. In the discharge simulation, constant current pulse discharge is possible through the GS610 pulse current sink operation. This enables simulation that takes into account the intermittent operation of mobile devices.

Solution Features

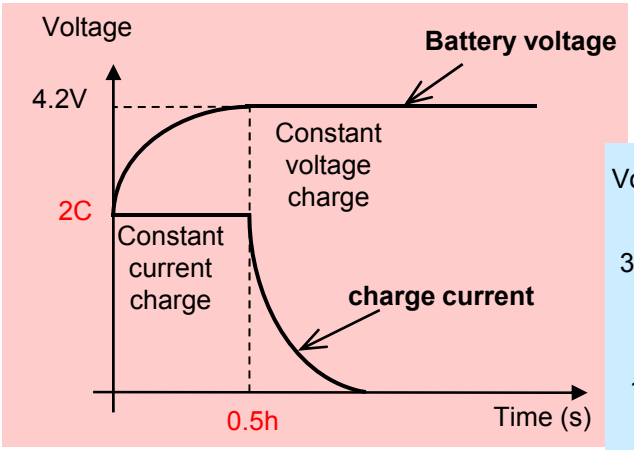
- Can charge and discharge up to max 3.2A
- Can charge and discharge with pulse current
- Can automatically switch from I source V measure to V source I measure (automatic VI function)
- Data collection and graph description using multipurpose worksheets
- No control software needed

GS610 Source Measure Unit

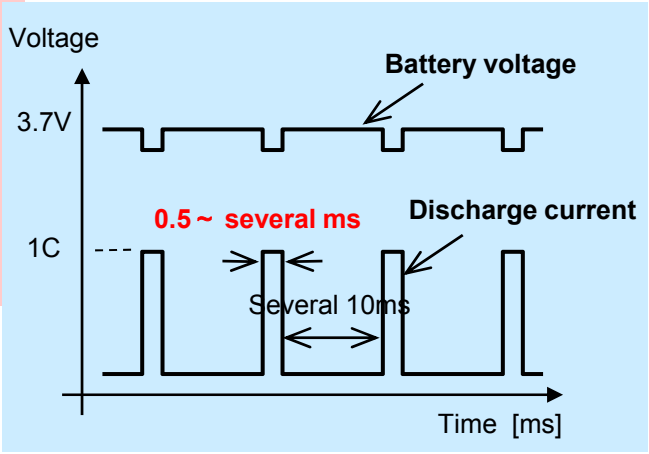


Lithium-ion battery
Nickel metal hydride battery
(400 ~ 1000mA/h for Cell-phone)

Charge Operation



Discharge operation by pulse current



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GS820 Two Channel Source Measure Unit Applications

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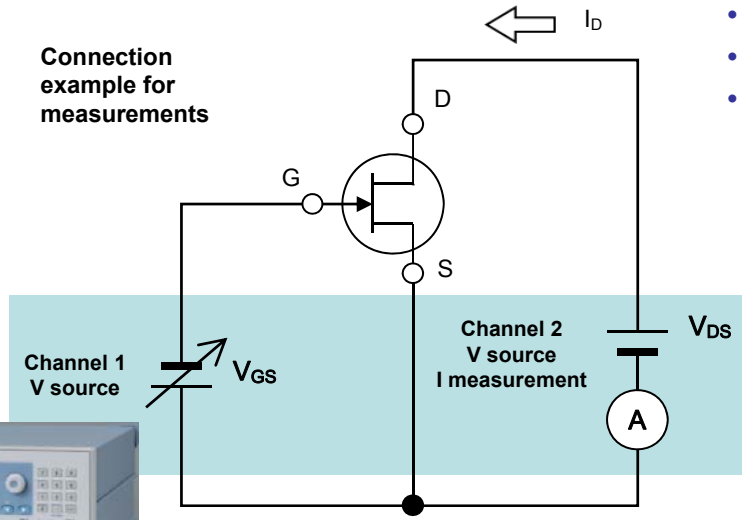
Measurement of the Static Characteristics of Semiconductor Devices (Transistors, FETs, etc.)

Application

The GS820 can measure drain current I_D by applying gate-source voltage V_{GS} from channel 1 and drain-source voltage V_{DS} from channel 2.

GS820
Source Measure Unit



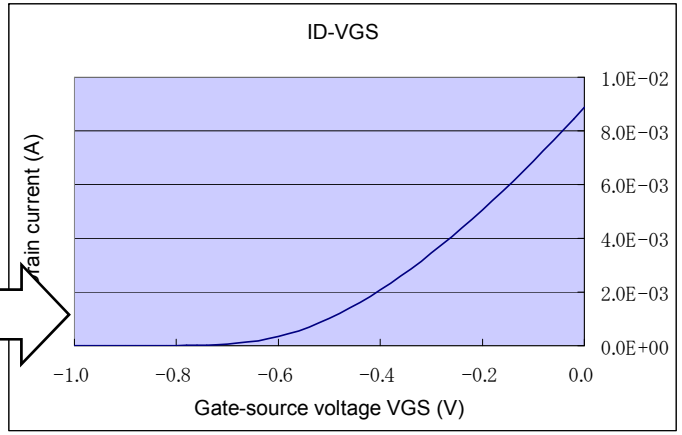
Drag & drop

Measurement data file

CH1.Vgs(V)	CH2.Id(A)
0.00E+00	8.87E-03
-2.00E-02	8.46E-03
-4.00E-02	8.05E-03
-6.00E-02	7.65E-03
-8.00E-02	7.26E-03
-1.00E-01	6.87E-
-1.20E-01	6.49E-03
-1.40E-01	6.12E-03
-1.60E-01	5.76E-03

(data edited in the spreadsheet)

Graph



Solution Features

- Voltage application and current measurement using two synchronized channels
- Minute current measurement at 200-nA range and 1-pA resolution
- Curve trace function using voltage/current sweep
- Output measured data in CSV format
- Easy access to the internal USB memory
- No dedicated software required

DC Characteristic Tests for Transistors

Application

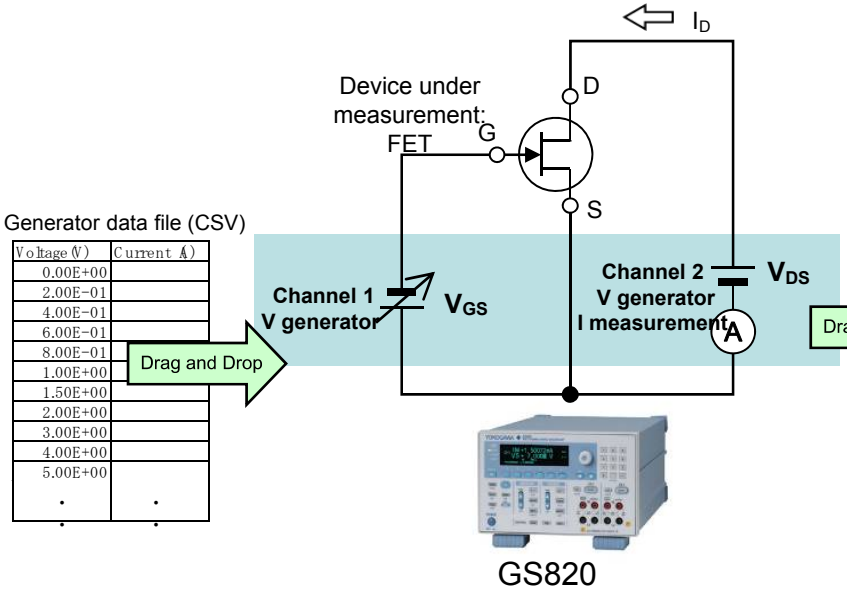
Measures transistor DC characteristics (Vgs-Id) such as bipolar and FET. GS820 measures drain current I_D by applying voltage V_{GS} between gate source from Channel 1 and applying voltage V_{DS} between drain source from Channel 2.

Application Points

Measures drain current by using the two built-in source measure channels in the unit by applying voltage between the gate sources. Can obtain the DC characteristic curve easily by graphing the measurement result worksheet from GS820.

Solution Features

- Measures current and voltage application from 2 synchronic channels
- Measures 200nA range and microcurrents of 1pA resolution
- Curve trace function with voltage/current sweep
- CSV output of measurement result data
- Easy access to built-in USB memory
- No dedicated software necessary



Device Under Test

- Transistor
- Diode
- LED, LD
- Voltage regulator
- Other discreet parts

Measurement of Power Conversion Efficiency for Voltage Regulator

Application

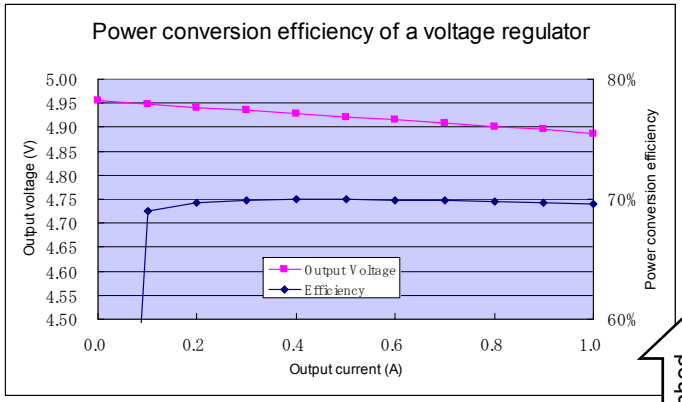
Measures power conversion efficiency of three-terminator regulators and DC-DC converters. Connect the power supply source measure on the primary side and the power consumption source measure on the secondary side to convert the consumption power and the supply power by sweeping the load current. The power conversion efficiency rate can be calculated by the ratio between the consumption power and the supply power.

Application Points

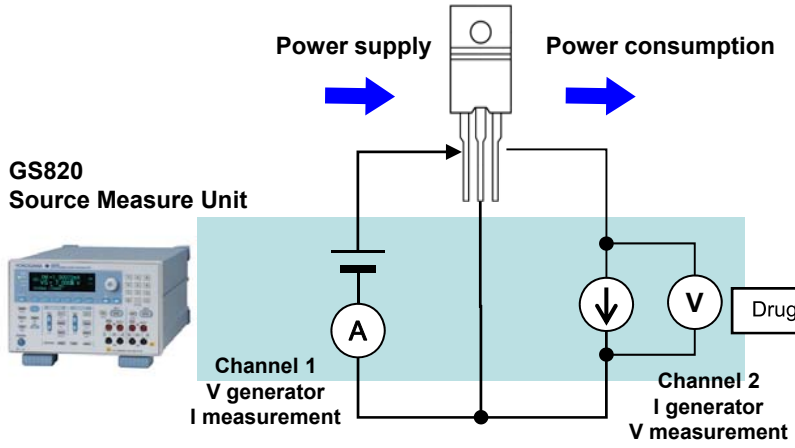
Two independent channels are built in one source measure unit. By using Channel 1 as the power source and Channel 2 as the electronic load, not only are two measurement functions combined into one device, but there is no need to synchronize the operation or integrate the measurement data. It saves space and reduces the evaluation time.

Solution Features

- Power supply and power consumption (load) operations
- Can generate and measure up to 7V/3.2A and 18V/1.2A
- Data collection and calculation using multipurpose worksheets
- No dedicated software necessary



Graphed



Drug and Drop

efficiency = Secondary consumption power / Primary supply power

Primary voltage current　Secondary voltage current

Time (s)	Source (V)	Measure (A)	Source (A)	Measure (V)	Input (W)	Output (W)	Efficiency
0	7.00	0.002617	0.00	4.95495	1.83E-02	0.00E+00	0.00%
0.55	7.00	0.102457	-0.10	4.94771	7.17E-01	4.95E-01	68.99%
1.1	7.00	0.202470	-0.20	4.94113	1.42E+00	9.88E-01	69.73%
1.65	7.00	0.302443	-0.30	4.93466	2.12E+00	1.48E+00	69.93%
2.2	7.00	0.402436	-0.40	4.92822	2.82E+00	1.97E+00	69.98%
2.75	7.00	0.502437	-0.50	4.92177	3.52E+00	2.46E+00	69.97%
3.3	7.00	0.602380	-0.60	4.91529	4.22E+00	2.95E+00	69.94%
3.85	7.00	0.702407	-0.70	4.90882	4.92E+00	3.44E+00	69.89%
4.4	7.00	0.802434	-0.80	4.90221	5.62E+00	3.92E+00	69.82%
4.95	7.00	0.902451	-0.90	4.89524	6.32E+00	4.41E+00	69.74%
5.5	7.00	1.002370	-1.00	4.88563	7.02E+00	4.89E+00	69.63%

Examples of measurement results (edited on worksheet)

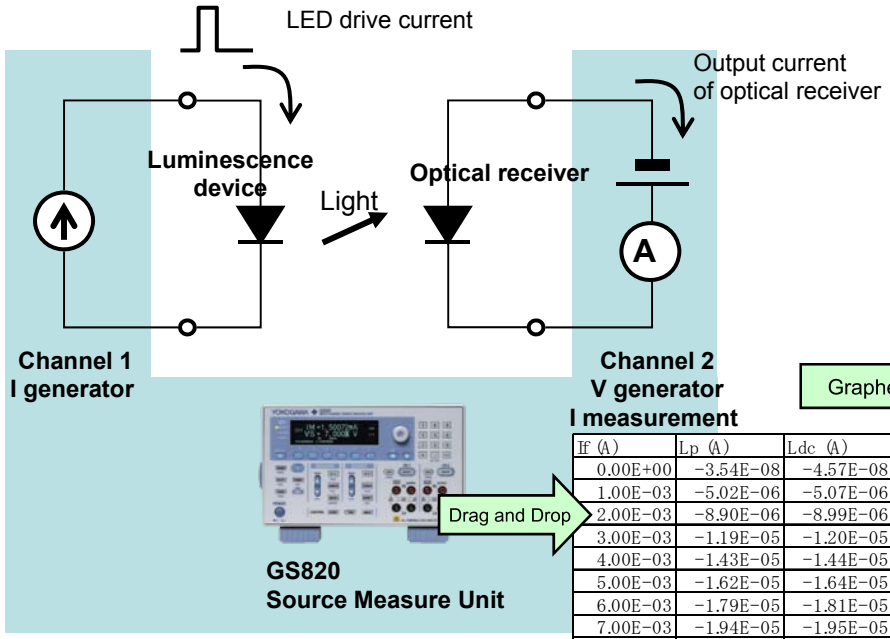
Measurement of LED and LD Drive Current and Amount of Luminescence

Application

Evaluates the relation between the drive current and amount of luminescence (I-L curve) by measuring the amount of luminescence with a constant current drive of light emitting diode (LED) and laser diode (LD).

Application Point

Measures the current in the receptor with Channel 2 by driving the luminescence device with the constant current output (DC or pulse) from Channel 1. The I-L curve is easy to obtain by graphing the measurement result worksheet from GS820.

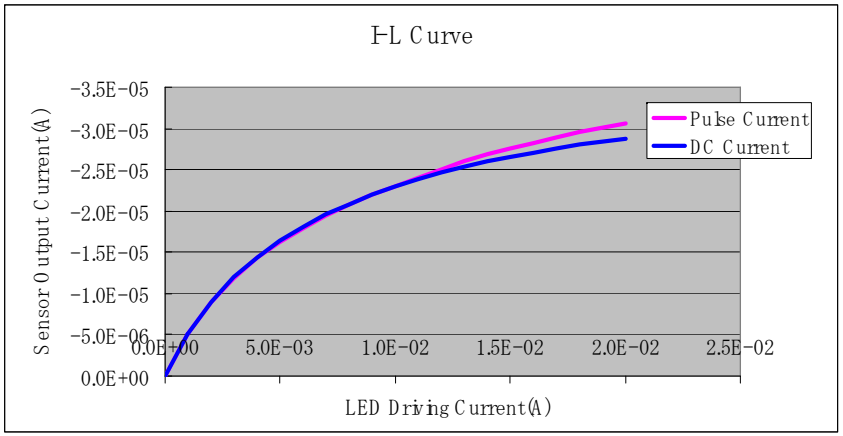


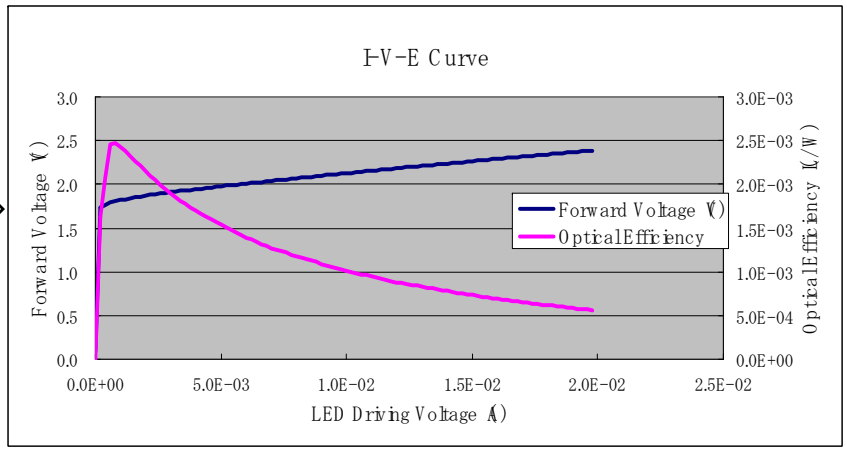
If (A)	Lp (A)	Ldc (A)
0.00E+00	-3.54E-08	-4.57E-08
1.00E-03	-5.02E-06	-5.07E-06
2.00E-03	-8.90E-06	-8.99E-06
3.00E-03	-1.19E-05	-1.20E-05
4.00E-03	-1.43E-05	-1.44E-05
5.00E-03	-1.62E-05	-1.64E-05
6.00E-03	-1.79E-05	-1.81E-05
7.00E-03	-1.94E-05	-1.95E-05
8.00E-03	-2.08E-05	-2.08E-05
9.00E-03	-2.20E-05	-2.19E-05
1.00E-02	-2.30E-05	-2.29E-05

Graphed

Solution Features

- DC and pulse constant current sweep output
- Easy current programming
- Measurement of amount of light received with microcurrent measurement range
- No dedicated software necessary





Linearity Test of AD Converter

Application

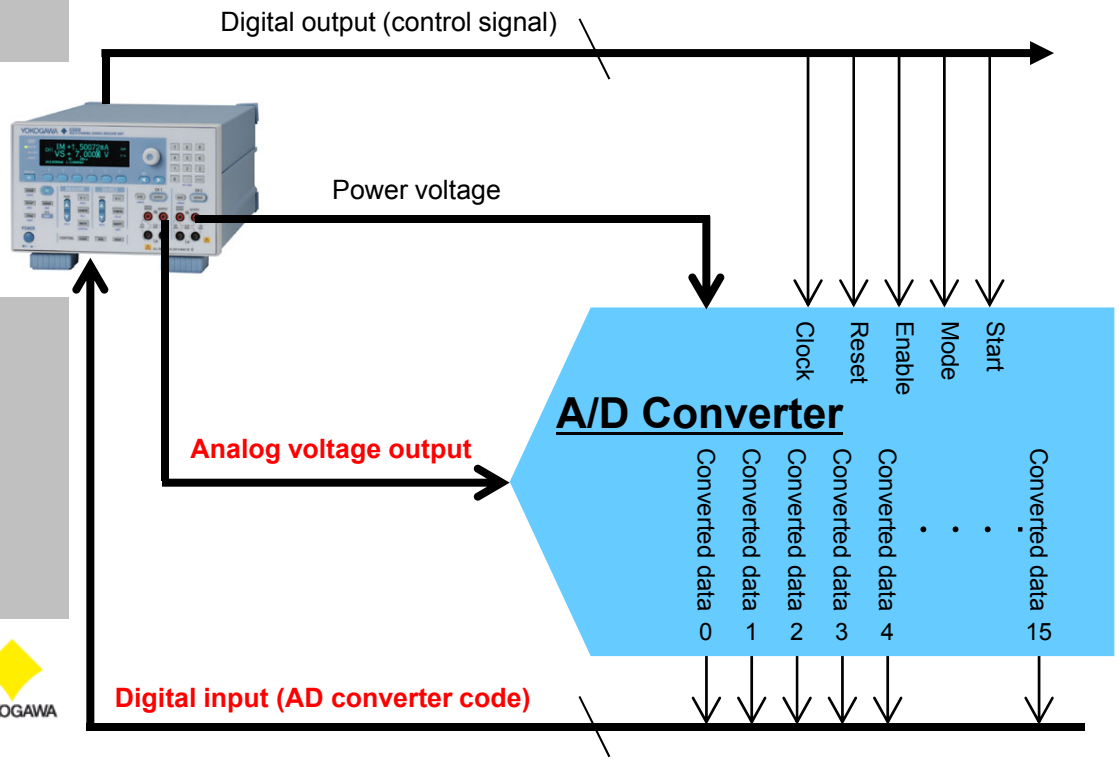
In addition to the two analog channels, GS820 has a 16 bit digital input/output, which generates analog signals entered into the AD converter as well as reads out controlled digital signals. It also reads digital data after AD conversion.

Solution Features

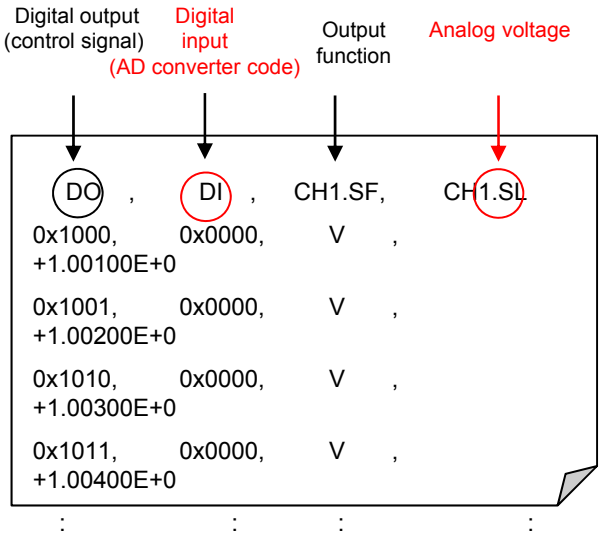
- 5.5 digit output voltage setting resolution
- Output range of 200.000mV to 18.0000V
- Two analog channels + 16 bit digital input/output
- Maximum output rate: 100µs
- Output voltage and pattern setting on CSV file
- Measurement result output on CSV file

Application Point

In addition to the two analog input/output channels, GS820 has a built-in 16 bit digital input/output which is suited for testing mixed analog/digital devices. It can easily define digital pattern output data and read digital input data on a worksheet.



Example of measurement result file



Start-up Timing Inspection of Multi Power Sources

Application

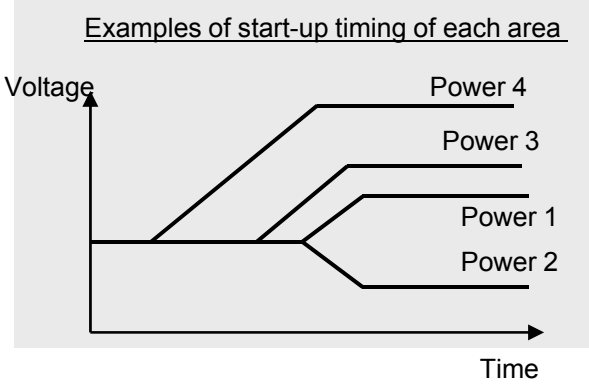
Inspects performance margins by timing the power start up in multi powered devices such as DVDs, CDs, and hard disks.

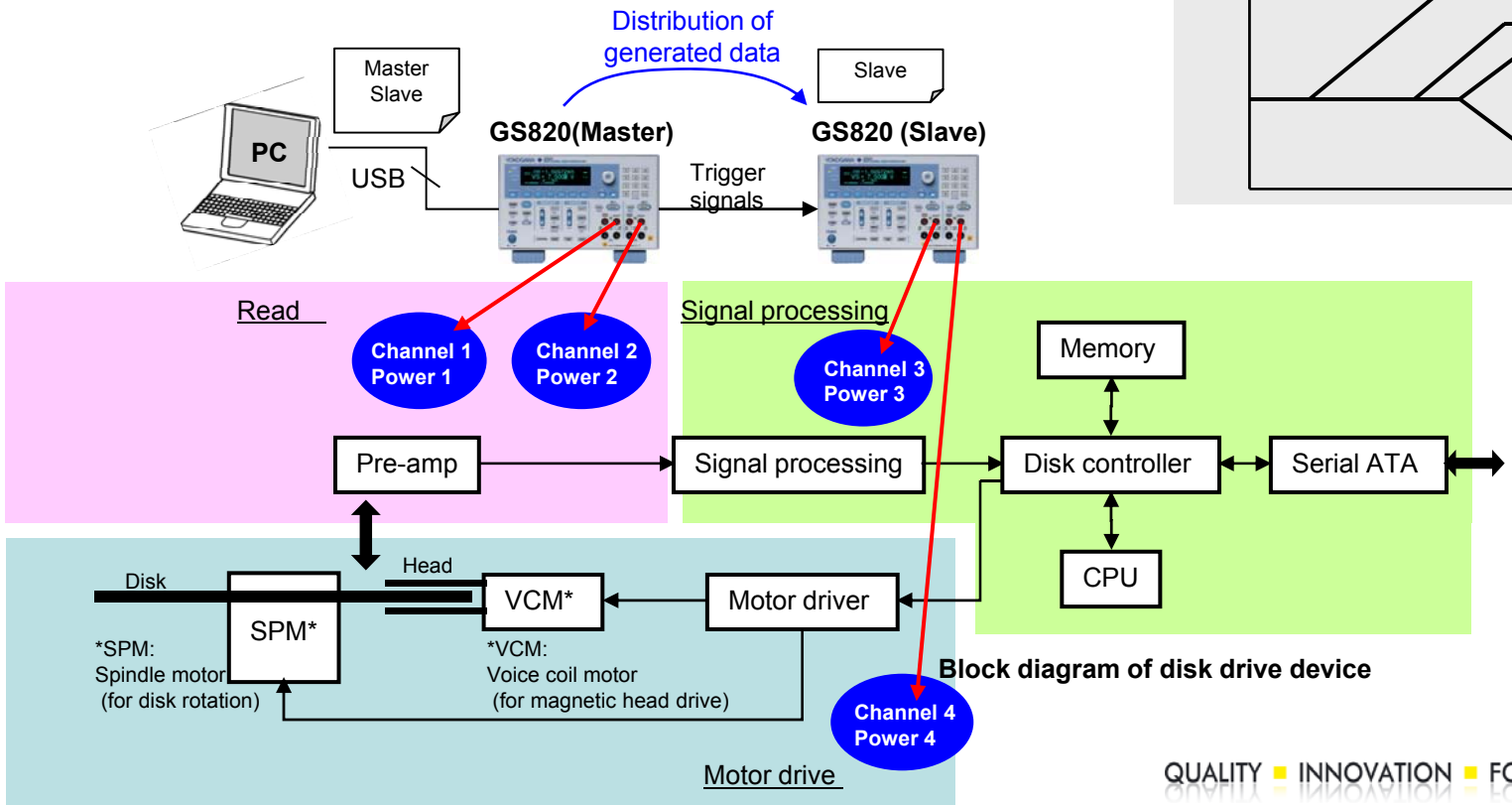
Solution Features

- Synchronized output of multiple electric power
- Maximum output current of 3.2A/channel
- Easy voltage programming
- No dedicated software necessary

Application Points

The master/slave synchronized link method makes multiple power supply possible. Can preset the output waveform data easily by defining the voltage waveform during start ups on the worksheet and drag and drop the data into the GS820 embedded memory.





Block diagram of disk drive device

Circuit Current Measurement of Variable Gain Amplifier

Application

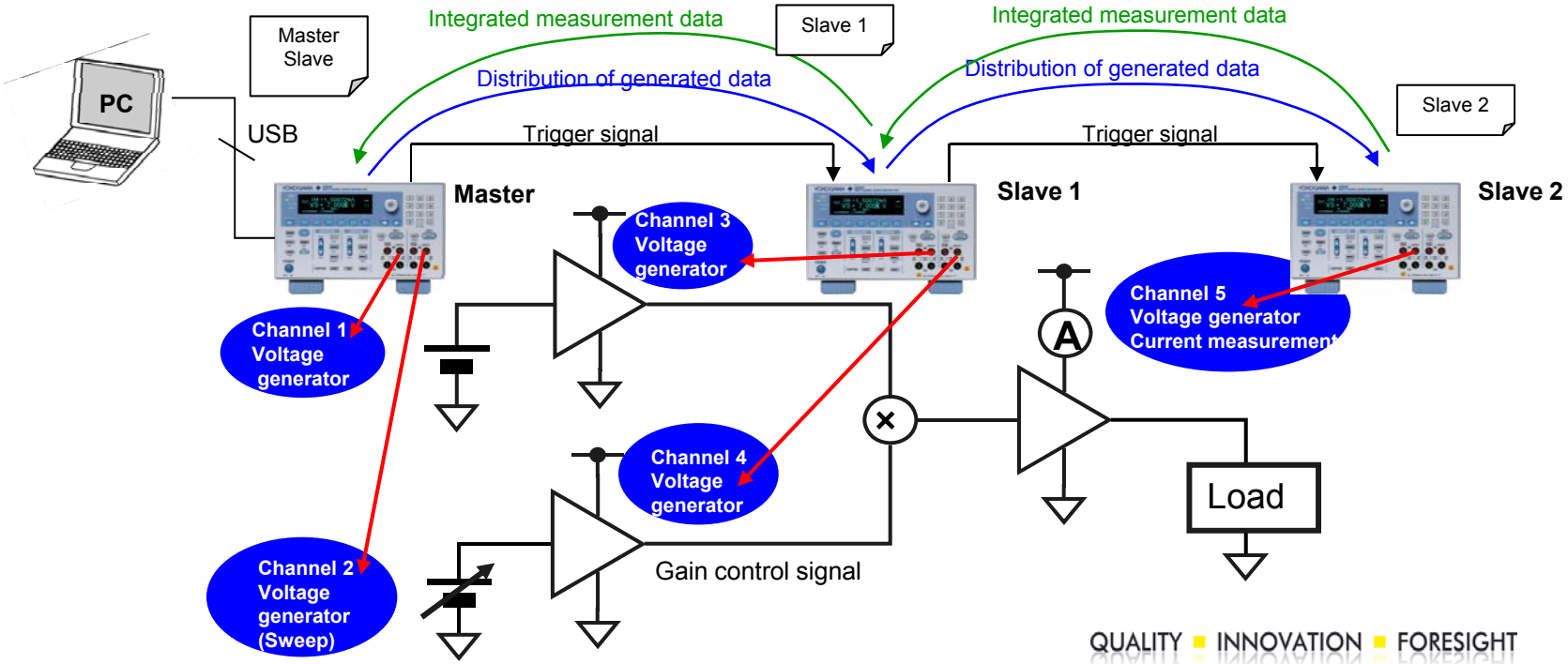
Measures circuit currents during gain changes in variable gain amplifiers used in areas such as mobile phones, TV, and audio devices.

Application Point

Synchronizes current measurement and multi point voltage application with master/slave synchronized link methods. The Master unit starts up the Slave unit just by pressing a key and can operate several channels in sync. The Master unit distributes the generated data from the Slave unit and collects and merges the measurement data from the Slave unit.

Solution Features

- Multichannel synchronic output and measurement of voltage and current
- Maximum of 3.2 A current capacity
- Generates and measures complete synchronization of all channels
- Can operate the Slave units in sync with the Master unit
- Can distribute the generated data and merge the measured data (Maximum of 10 channels)



Matrix Drive of LCD, Organic EL, and LED Displays

Application

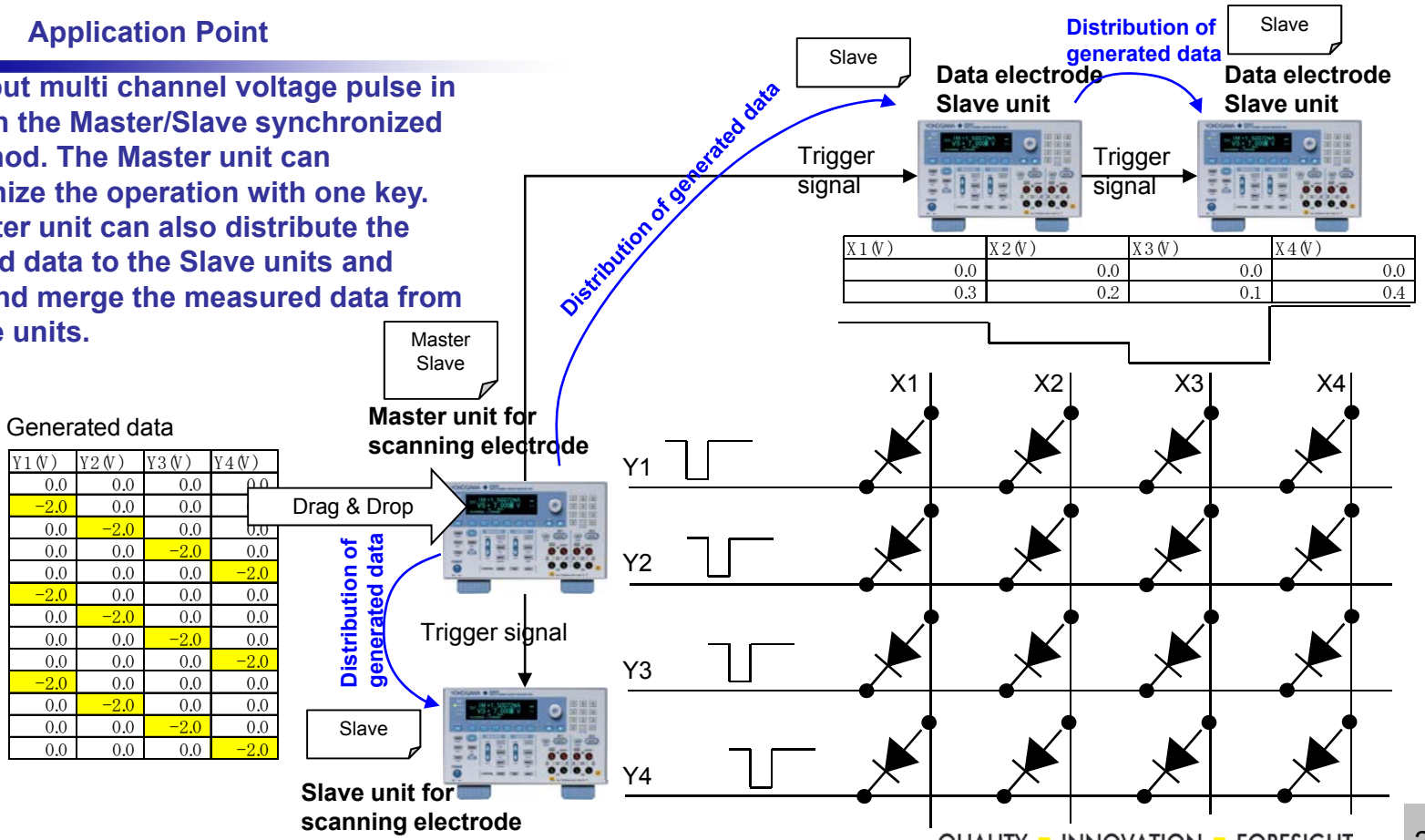
Operate several units of GS820 Source Measure Unit (SMU) in sync to drive the display test cells connected to the matrix. Prepare a unit for scanning electrode and data electrode as shown in the below figure to control the timing of the drive signal generator by sending trigger signals from the Master unit to several Slave units.

Application Point

Can output multi channel voltage pulse in sync with the Master/Slave synchronized link method. The Master unit can synchronize the operation with one key. The Master unit can also distribute the generated data to the Slave units and collect and merge the measured data from the Slave units.

Solution Features

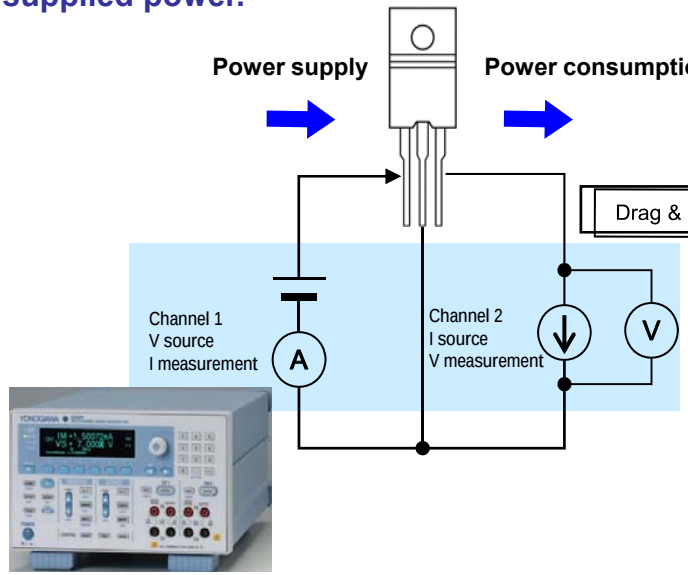
- Multi channel synchronized output of pulse voltage
- Maximum 3.2A/channer of current capacity
- Can synchronize operation with Master unit only
- Can distribute generated data automatically and merge the measured data results (Maximum of 10 channels)



Power Conversion Efficiency Measurement of Power Supply ICs

Application

The GS820 can measure the power conversion efficiency of a three-terminal regulator or a DC-DC converter. A channel for supplying power is connected to the primary circuit and another channel for consuming power is connected to the secondary circuit. Then, the load current is swept to vary the consumed power and supplied power. The power conversion efficiency is determined from the ratio of the consumed power to the supplied power.



GS820 Source Measure Unit

Solution Features

- Power supply operation and power consumption (load) operation
- Generate and measure up to 7 V and 3.2 A or 18 V and 1.2 A
- Data collection and calculation using general-purpose spreadsheets
- No dedicated software required

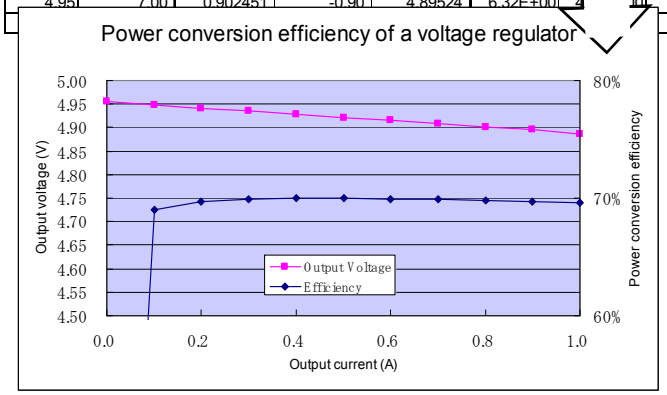
Measurement result example (data edited in the spreadsheet)

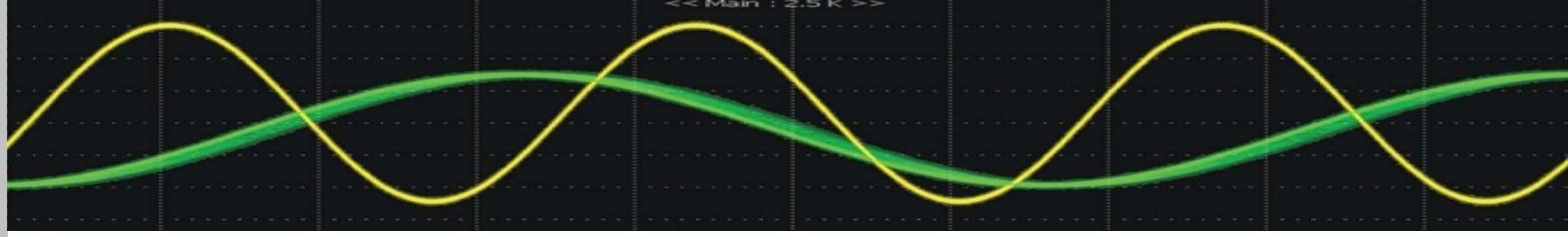
Voltage and current in the primary circuit | Voltage and current in the secondary circuit | Efficiency = Consumed power in the secondary circuit / supplied power in the primary circuit

Drag & drop

e(s)	Source(V)	Measure(A)	Source(A)	Measure(V)	Input(W)	Output(W)	Efficiency
0	7.00	0.002617	0.00	4.95495	1.83E-02	0.00E+00	0.00%
0.55	7.00	0.102457	-0.10	4.94771	7.17E-01	4.95E-01	68.99%
1.1	7.00	0.202470	-0.20	4.94113	1.42E+00	9.88E-01	69.73%
1.65	7.00	0.302443	-0.30	4.93466	2.12E+00	1.48E+00	69.93%
2.2	7.00	0.402436	-0.40	4.92822	2.82E+00	[illegible]	69.98%
2.75	7.00	0.502437	-0.50	4.92177	3.52E+00	[illegible]	69.97%
3.3	7.00	0.602380	-0.60	4.91529	4.22E+00	[illegible]	69.94%
3.85	7.00	0.702407	-0.70	4.90882	4.92E+00	[illegible]	69.89%
4.4	7.00	0.802434	-0.80	4.90221	5.62E+00	[illegible]	69.82%
4.95	7.00	0.902451	-0.90	4.89524	6.32E+00	[illegible]	69.74%
							69.63%

Graph





Source Measure Unit Selection Guide

YOKOGAWA

GS610 and GS820 Source Measure Units

Source Measure Unit Selection Guide

Function	GS610	GS820
Generation	Voltage or Current	Isolated 2 Channel Voltage/Voltage Current/Current Voltage/Current
Generation Mode	DC or Pulse	DC or Pulse
Voltage Generation	200 mV, 1 µV Resolution to 110 V	200 mV, 1 µV Resolution to 18 V
Current Generation	20 µA, 100 pA Resolution to 3.2 A	200 nA, 1 pA Resolution to 3.2 A
Sweep Modes	Linear, Log, Program	Linear, Log, Program
Measurements	Voltage, Current, Resistance	Voltage, Current, Resistance
Data Storage	Up to 65.5K Data Points	Up to 100K Data Points
Pulse Width	100 µsec to 3600 sec, 1 µsec resolution	50 µsec to 3600 sec, 1 µsec resolution
Period Time	1 mS to 3600 sec, 1 µsec resolution	100 µsec to 3600 sec, 1 µsec resolution
Output Noise (Typical)	8 mV P-P DC to 20 MHz	20 mV P-P DC to 20 MHz
Interface	GPIB, USB & RS232 Standard, Ethernet Optional	GPIB, USB, RS232 and Ethernet all standard