

## HIGH PRECISION SOURCE MEASURE UNIT MODEL 52400e SERIES

The Chroma 52400e series is a PXIe based SMU (Source Measurement Unit) card designed for highly accurate source or load simulation with precision voltage and current measurements.

The SMU combines four-quadrant operation with precision and high speed measurement. This makes the SMU an ideal instrument in many parametric test applications ranging from ICs, two-leaded components such as sensors, LEDs, laser diodes, transistors, to solar cells, batteries and many other electronic devices.

The 52400e series features: 16 selectable control bandwidths to ensure high speed output and stable operation; multiple source/measure ranges with an 18-bit DAC/ADC to provide the best resolution and accuracy available with a sampling rate up to 100K s/S; programmable internal series resistance for battery simulation;  $\pm$ force,  $\pm$ sense and  $\pm$ guards lines to avoid leakage current and

reduce settling time -- especially useful for low current test applications.

The 52400e series has a patented hardware sequence engine that uses deterministic timing to control each SMU. The sequencer's on-board memory can store up to 65535 sequencer commands and 32k measurement samples per channel, allowing cross module/card synchronization and latency free output control and measurement. No PC communication is required during execution of the hardware sequencer test process.

C, C#, LabView, LabWindows APIs and versatile soft front panels come standard with each SMU. The back connectors are compatible with both PXIe and hybrid chassis. All of these features enable easy integration to PXIe or PXI-hybrid systems designed for a wide range of applications.

## MODEL 52400e Series

### KEY FEATURES

- 1- Slot PXI express module
- 2/4 independent channels  
(4 ch for Model 52401e-7-1)
- 18-bit resolution
- Four quadrant operation
- 6-wire Force/Sense/Guard
- Low output noise
- DIO/Trigger bits
- Deterministic hardware sequencer
- Programmable resistance
- 16 control bandwidth selection
- Master/Slave operation
- LabView/LabWindows & C/C#
- Softpanel GUI

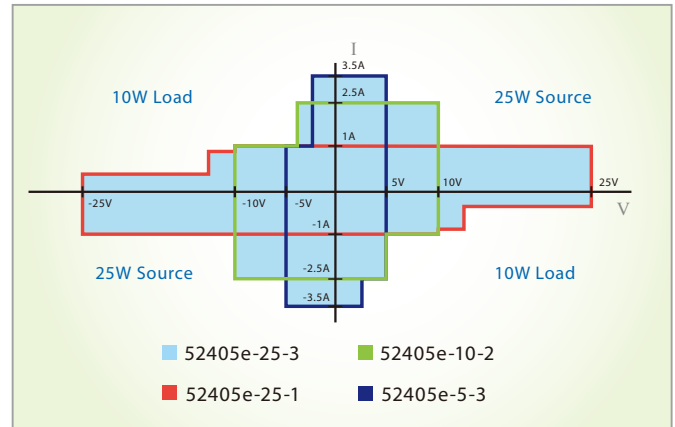
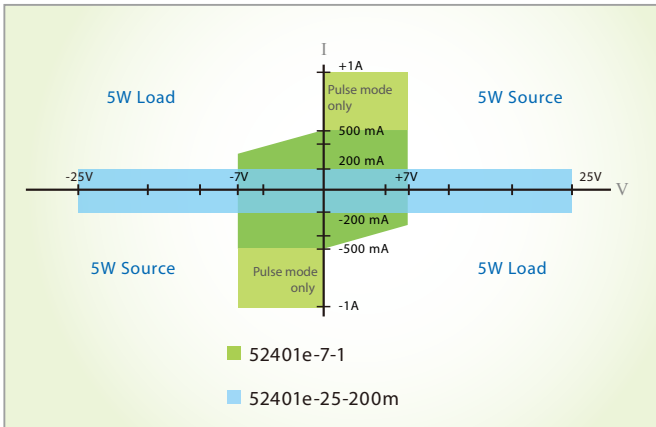
### APPLICATIONS

- Semiconductor
- LED / Laser Diode
- Solar Cell
- Battery / BMS
- Transistor
- Automotive
- Avionics
- Power Electronics
- Sensor / IoT



## FOUR QUADRANT OPERATION

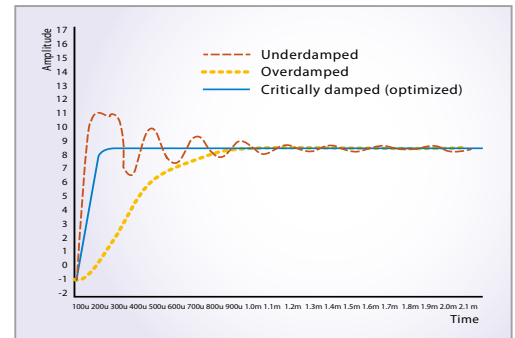
All Chroma 52400e series SMUs support four quadrant operation for applications that require a reverse voltage/current source or load. During a load operation, the module can dissipate up to 20W per slot. Shown below are the quadrant diagrams with the operating regions of the Chroma PXIe SMUs:



## CONTROL BANDWIDTH SELECTION

To reduce test times, Chroma's SMUs are designed for fast response providing high speed output voltage and current. The impedance of the DUT, fixture, or cabling may cause loop instability under voltage or current source mode. An unstable loop can cause saturation, oscillation, or even damage the DUT.

To prevent system instability, the 52400e series SMUs provide 16 user selectable control bandwidths, eliminating the need for external capacitors or inductors placed near the DUT. This results in faster output rise time, reduced voltage ripple and noise, and reduced transient response. The control bandwidth can be modified via software to maximize test flexibility and minimize downtime when changing DUTs.

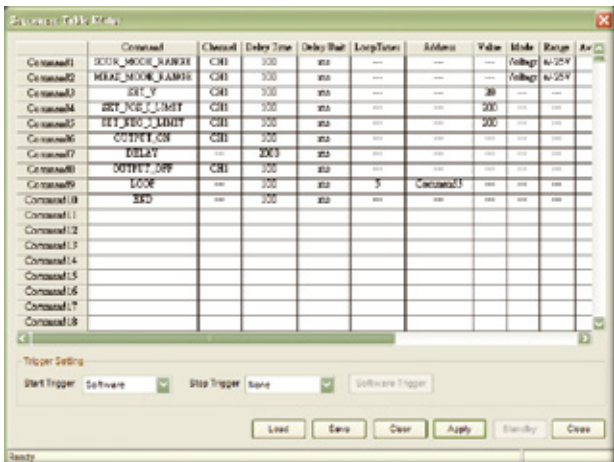


SMU Output Waveform under Bandwidth Control

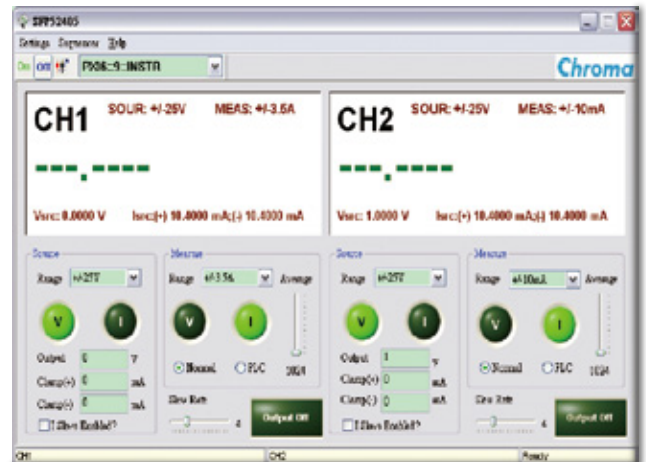
## UNIQUE HARDWARE SEQUENCER

The Chroma Hardware Sequencer is a powerful tool that can predefine commands as instrument executable steps. This allows latency free control and measurement since no PC interaction is required during execution. Once the instrument receives the start trigger, it will execute step commands in the sequencer table line by line or as defined by the trigger. Shown below are the soft panels for the SMU in hardware sequencer mode (left) and direct operation mode (right).

## VERSATILE SOFT FRONT PANEL

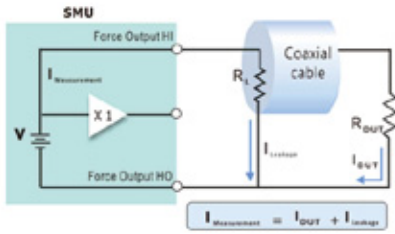


Hardware Sequencer Mode Soft Front panel

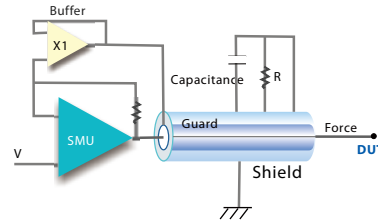


Direct Operation Mode Soft Front Panel

## GUARDING FOR LOW CURRENT APPLICATION



Leakage current flows through the cable's insulation resistance



Guard Connection: Cable Capacitance is eliminated with Triaxial Cable

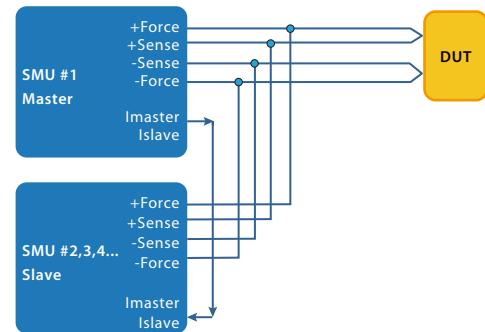
Guarding is an important technique for very-low current measurements. Guarding reduces leakage current error and decreases settling time. This is achieved by keeping the potential of the guard connector at the same potential as the force conductor, so current does not flow between the force and guard conductors. Guarding also eliminates the cable capacitance between the SMU and DUT.

The Chroma 52400e series features two  $\pm$  guard wires per channel, resulting in faster and more accurate measurements.

## MASTER/SLAVE OPERATION

For maximum flexibility, the Chroma 52405e SMUs support Master/Slave operation when higher current under FVMI (Force Voltage Measure Current) mode is required. To ensure accurate current sharing between modules and maximum performance, Master/Slave operation is only allowed between SMUs of the same model number.

Current sharing is achieved by one channel operating as the Master under FVMI mode while the Slaves operate in FIMV mode. The Master channel is programmed in voltage mode while the Slaves are set to current mode. The Slaves will follow the Master's set voltage. The wiring diagram for current sharing in master/slave control is shown to the right.



Wiring Structure for Master/Slave Control

## SPECIFICATIONS

Model Name	52401e-7-1	52401e-25-200m	52405e-5-3 *1	52405e-10-2 *1	52405e-25-1 *1	52405e-25-3 *1
Slots	1					
Output Channels	4	2				
Source	3.5W x 4	5W x 2	25W x 2			
Load	1.8W x 4	5W x 2	10W x 2			
Input Voltage	Backplane Power		External 48VDC source required *2			
Input Current	Peripheral 4A@+12V	0.7A Max	2.2A Max			
Output Isolation	Isolated but share common LO		Isolated by External Power Supply			
Bit Resolution	20 bits for measurement 16 bits for programming		18 bits			
Programmable Loop Bandwidth	8 steps		16 steps			
Settling Time	<30 $\mu$ Sec, typically					
Force Voltage ranges	$\pm 7V$	$\pm 25V, \pm 10V, \pm 5V, \pm 2.5V, \pm 1V, \pm 500mV$	$\pm 5V, \pm 2V, \pm 1V, \pm 500mV, \pm 200mV, \pm 100mV$	$\pm 10V, \pm 5V, \pm 2V, \pm 1V, \pm 500mV, \pm 200mV, \pm 100mV$	$\pm 25V, \pm 12.5V, \pm 10V, \pm 5V, \pm 2V, \pm 1V, \pm 500mV, \pm 200mV, \pm 100mV$	$\pm 25V, \pm 12.5V, \pm 10V, \pm 5V, \pm 2V, \pm 1V, \pm 500mV, \pm 200mV, \pm 100mV$
Force Current Ranges	$\pm 1A$ (Pulse mode), $\pm 500mA, \pm 100mA, \pm 10mA, \pm 1mA, \pm 100\mu A, \pm 10\mu A$	$\pm 200mA, \pm 20mA, \pm 2mA, \pm 200\mu A, \pm 20\mu A, \pm 2\mu A, \pm 200nA$	$\pm 3.5A, \pm 2.5A, \pm 1A, \pm 100mA, \pm 10mA, \pm 1mA, \pm 100\mu A, \pm 10\mu A, \pm 1\mu A$	$\pm 2.5A, \pm 1A, \pm 100mA, \pm 10mA, \pm 1mA, \pm 100\mu A, \pm 10\mu A, \pm 1\mu A$	$\pm 1A, \pm 100mA, \pm 10mA, \pm 1mA, \pm 100\mu A, \pm 10\mu A, \pm 1\mu A$	$\pm 3.5A(\leq 5V), \pm 2.5A(\leq 10V), \pm 1A, \pm 100mA, \pm 10mA, \pm 1mA, \pm 100\mu A, \pm 10\mu A, \pm 1\mu A$
Measure Voltage Ranges	$\pm 7V$	$\pm 25V, \pm 10V, \pm 5V, \pm 2.5V, \pm 1V, \pm 500mV, \pm 250mV, \pm 100mV, \pm 50mV, \pm 25mV, \pm 10mV, \pm 4mV$	$\pm 5V, \pm 2V, \pm 1V, \pm 500mV, \pm 200mV, \pm 100mV$	$\pm 10V, \pm 5V, \pm 2V, \pm 1V, \pm 500mV, \pm 200mV, \pm 100mV$	$\pm 25V, \pm 12.5V, \pm 10V, \pm 5V, \pm 2V, \pm 1V, \pm 500mV, \pm 200mV, \pm 100mV$	$\pm 25V, \pm 12.5V, \pm 10V, \pm 5V, \pm 2V, \pm 1V, \pm 500mV, \pm 200mV, \pm 100mV$
Measure Current Ranges	$\pm 1A$ (Pulse mode), $\pm 500mA, \pm 100mA, \pm 10mA, \pm 1mA, \pm 100\mu A, \pm 10\mu A$	$\pm 200mA, \pm 20mA, \pm 2mA, \pm 200\mu A, \pm 20\mu A, \pm 2\mu A, \pm 200nA$	$\pm 3.5A, \pm 2.5A, \pm 1A, \pm 100mA, \pm 10mA, \pm 1mA, \pm 100\mu A, \pm 10\mu A, \pm 1\mu A$	$\pm 2.5A, \pm 1A, \pm 100mA, \pm 10mA, \pm 1mA, \pm 100\mu A, \pm 10\mu A, \pm 1\mu A$	$\pm 1A, \pm 100mA, \pm 10mA, \pm 1mA, \pm 100\mu A, \pm 10\mu A, \pm 1\mu A$	$\pm 3.5A(\leq 5V), \pm 2.5A(\leq 10V), \pm 1A, \pm 100mA, \pm 10mA, \pm 1mA, \pm 100\mu A, \pm 10\mu A, \pm 1\mu A$

## SPECIFICATIONS

Model Name	52401e-7-1	52401e-25-200m	52405e-5-3 *1	52405e-10-2 *1	52405e-25-1 *1	52405e-25-3 *1
Force Voltage Accuracy	0.02% reading + 0.01% F.S.	0.05% reading + 0.0076% F.S. (≥500mV Range) 0.02% reading + 25uV (<500mV Range)	0.05% reading + 0.008% F.S. (≥500mV Range) 0.05% reading + 25uV (<500mV Range)			
Force Current Accuracy	0.1% reading + 0.1% F.S. (1A Range) 0.05% reading + 0.05% F.S. (<1A Range)	0.05% reading + 0.05% F.S. (≥2uA Range) 0.05% reading + 200pA (<2uA Range)	0.1% reading + 0.1% F.S. (>1A Range) 0.05% reading + 0.05% F.S. (≤1A Range)			
Measure Voltage Accuracy	0.02% reading + 0.01% F.S.	0.05% reading + 0.0076% F.S. (≥500mV Range) 0.05% reading + 25uV (<500mV Range)	0.05% reading + 0.008% F.S. (≥500mV Range) 0.05% reading + 25uV (<500mV Range)			
Measure Current Accuracy	0.1% reading + 0.1% F.S. (1A Range) 0.05% reading + 0.05% F.S. (<1A Range)	0.05% reading + 0.05% F.S. (≥2uA Range) 0.05% reading + 200pA (<2uA Range)	0.1% reading + 0.12% F.S. (>1A Range) 0.05% reading + 0.05% F.S. (≤1A Range)			
Wideband Source Noise	< 20 mV pp 20Mhz BW No Load					
Measurement Sampling Rate	600K Samples/s		100K Samples/s			
Output Connection	5 Wires (± Force, ± Sense, +Guard)		6 Wires (± Force, ± Sense, ± Guard)			
Measurement Log	32K Samples/channel					
Output Profiling	65535 Steps					
Trigger Input	Programmable 4 Ch		1 Ch		Programmable 8 Ch	
Trigger Output						
Floating Output	No		Channel Isolated			
Master/Slave Mode	Yes		No		Yes	
Programmable Resistance	Yes		No		Yes	
Regulatory Compliance	CE/FCC					

Note \*1 : If chassis has less than 38.2W/slot, then the below output limitations apply.

2.5Amp range = 50% on duty cycle, 500mSec maximum continuous on time

3.5Amp range = 40% on duty cycle, 500mSec maximum continuous on time (1250mSec off during maximum on time case)

If the PXI-SMU card is over temperature, it will automatically disconnect output to protect the unit.

Note \*2 : Required Voltage Range 48V ± 5% ; Required Voltage Noise ≤ 100mVpp

All specifications are subject to change without notice.

## ORDERING INFORMATION

52401e-7-1: High Precision Source Measurement Unit, 7V/1A

52401e-25-200m : High Precision Source Measurement Unit, 25V/200mA

52405e-5-3 : High Precision Source Measurement Unit, 5V/3.5A

52405e-10-2 : High Precision Source Measurement Unit, 10V/2.5A

52405e-25-1 : High Precision Source Measurement Unit, 25V/1A

52405e-25-3 : High Precision Source Measurement Unit, 25V/3.5A

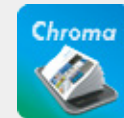
Optional:

A524006 : External AC-DC Power Adapter (drives up to 3x 52401e or 1x 52405e SMUs)

A524011 : High Power External AC-DC Adapter (drives up to 3x 52405e SMUs)

A524009 : 52405e Output Triaxial Cable

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