



Quick Start Guide:

Keysight Technologies B1500A automated temperature control of a Lake Shore Vertical Field (VF) Probe Station

I. Introduction

Before you begin, read and understand the user manuals for your Lake Shore probe station, Keysight B1500A, as well as the Keysight EasyEXPERT[™] software.



Figure 1: Probe movement (exaggerated for emphasis)

II. Probes

Automated temperature control requires use of Lake Shore's patented CVT probes.

- During a variable temperature measurement, these probes compensate for probe arm thermal expansion.
- Refer to the table below to determine the maximum temperature range of the automated measurement for your station and choice of probe. To extend the temperature range of measurement, stop the automated measurement at the range limit, lift and re-land the probes, and continue the automated measurement.

	CPX CPX-VF CPX-HF CPX-VF	TTPX EMPX-HF FWPX RX-6.5K CRX-4K CRX-EM-HF
ZN50R-CVT-25-W	Δ 400 K	∆150 K
ZN50R-CVT-10-W	∆200 К	Δ100 K
ZN50R-CVT-25-BECU	∆200 К	Δ100 K

Table 1: Temperature range per probe station model using CVT probes

III.EasyEXPERT™ Driver for the Model 336 Temperature Controller

Set the following settings in the EasyEXPERT[™] software to control the Lake Shore Model 336 temperature controller.

<u>File Edit View</u>	<u>R</u> un <u>T</u> ools <u>H</u> elp					
Device	ID :					
Category	Lake Shore 336 CRX-4	(Setup Nan	e: Lake Shore 30	к		
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ig Solar Cell						Run Options
						Count : 2
						Device ID :
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La	ke Shore 70K	12/14/2015 6:03:19 PM	2			
Initial Workspace		L Thermometer OFF 🔂 Multi Dis	play OFF 🕕 Standb	y OFF 📧 SMU Zero O	FF Auto Export C	OFF Auto Record ON

1. Model 336 GPIB Address: Set the GPIB address for the Model 336 temperature controller.

Figure 2: Model 336 GPIB address

2. Final Temperature: Set the Model 336 temperature controller to read temperature in Kelvin (K).

<u>File Edit View Run T</u> ools <u>H</u> elp	
Device ID :	
Category Lake Shore 336 CRX-4K	Setup Name : Lake Shore 30K
Device Parameters	▶ 0
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TempSettleBar	id : 250 mdegree 🖩 RampUpRate : 3.0 degree 📓 🛛 🖥 Lake Shore
SampleDel	av: 10 B RampDownRate: 500 mdegree B
	Id-Vg GM(1)
Flag Setup Name	Date Count Device ID Remarks ^
Lake Shore 90K	12/14/2015 6:21:38 PM 2
Z Id-Vg GM(3) Lake Shore 70K	12/14/2015 6:03:12 PM 2 12/14/2015 6:03:19 PM 2
Initial Workspace	🕼 Thermometer OFF 📑 Multi Display OFF 🝈 Standby OFF 🔰 SMU Zero OFF 📑 Auto Export OFF 📑 Auto Record ON

Figure 3: Final temperature

3. **Ramp Rates:** Set ramp rates to improve the stage control as well as the lag in probed device temperature. Ramp rates (in degree/min) are the rate that the temperature controller increases or decreases the sample stage setpoint.

<u>File Edit View</u>	<u>R</u> un <u>T</u> ools <u>H</u> elp							
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La La	ke Shore 90K 12	14/2015 6:21:38 PM						
La	ke Shore 70K 12	12/14/2015 6:03:19 PM 2						
Initial Workspace	τ ι].	rmometer OFF 🔡 Multi Dis	play OFF 🕕 Standby OF	F F SMU Zero OFF	Auto Export OFF	Auto Record ON		

Figure 4: Ramp rates

4. **Temperature Settle Band:** The stage temperature is considered stable when an approximately 30 s long string of temperature readings are within the range "FinalTemp" ±"TempSettleBand". Too narrow of a settle band may cause the program to timeout and stop.

<u>File Edit View Run T</u> ools <u>H</u> elp	
Device ID :	
to Category → Lake Shore 336 CRX-4K	Setup Name : Lake Shore 30K
E Reliability A Device Parameters	▶ . Ø
Solar Cell	Run Options
SPGU_PLSDI	Count : 2 📓 0
	Device ID :
Test Parameters	Extended Setup
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Lake Shore Lakeshore336G	VIBaddress : 12 Baseline
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	Id-Vg
FinalTemp	30.00 degree 🔳
	Id-Vg GM
	× 💌
TempSettleBa	nd : 250 mdegree
SampleDe	lay: 10 🔳 RampDownRate: 500 mdegree 🖩
23 •	Id-Vg GM(1)
	Date Count Device TD Demarks
	12/14/2015 6-21-22 DM 2
Id-Va GM(3)	12/14/2015 6:03:22 PM 2
Lake Shore 70K	12/14/2015 6:03:19 PM 2
Initial Workspace	🔢 Thermometer OFF 🛃 Multi Display OFF 🔞 Standby OFF 🕅 SMU Zero OFF 🗐 Auto Export OFF 📑 Auto Record ON

Figure 5: **Temperature settle band**

5. **Sample Delay:** Once the stage has stabilized, the program will wait for the "SampleDelay" time (in minutes) before completing and releasing control back to the B1500A. This wait time allows the device to come into complete thermal equilibrium with the stage and probes.

Eil	le <u>E</u> dit <u>V</u> iew	<u>R</u> un <u>T</u> ools <u>H</u> elp						
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esul	La	-Va GM(3)	12/14/2015 6:03:22 PM 2					
-	Lā	ke Shore 70K	12/14/2015 6:03:19 PM 2			-		
Initia	al Workspace		👃 Thermometer OFF 🔡 Multi Display	OFF 🕕 Standby OFF	I SMU Zero OFF Auto Export	OFF Auto Record ON		

Figure 6: Sample delay

Operation:

- 1. The temperature ramps to the setpoint.
- 2. PID control parameters are embedded in the driver and tuned for each model of the Lake Shore probe station.
- 3. The driver checks that the stage temperature has settled.
- 4. The device waits for the thermalization wait time.
- 5. The driver releases control for device measurement.

IV.EasyEXPERT[™] Driver for the Model 625 Superconducting Magnet Power Supply

Set the following settings in the EasyEXPERT[™] software to control the Lake Shore Model 625 superconducting magnet power supply.

Category Category Category CMOS Discrete GenericTest Lakeshore	LakeShore 625 GoToFi	eld	Setup Name :	LakeShore 625 GoTol					
MCSMU_TV V Memory V Lake Shore 336 CRX-VF Lake Shore COTOField	Test Parameters	Lakeshore336GPIBaddress Lakeshore625GPIBaddress Field_B : 0	s: <u>12</u> 9 9 0	MagnetChanne	1336 : β	Extended Set	up v aves	y Favorite	
Hag Se	tup Name	Date	Count	Device ID	Remarks				
Keenic							1		

1. Model 625 GPIB Address: Set the GPIB address for the Model 625 magnet power supply.

Figure 7: Model 625 GPIB address

2. Field: Set the Model 625 magnet power supply to the desired field, in Tesla (T).

Keysight EasyEXPER File Edit View Run	Tools Help							-	
blank	Toon Teb	▶4	\$	Device ID	:	Count : 0	0→		
ts Category ▼	LakeShore 625 GoToField	0	Setup Name :	LakeShore 625 GoTo	pField			My Favori	ite 🔻
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Flag Se	tup Name	Date	Count	Device ID	Remarks				
Result									
blank			Thermometer OFF	Multi Display OFF	() Standby OFF	0 SMU Zero OFF	Auto Export OFF	Aut:	o Record ON

Figure 8: Field

3. **GPIB Address for the Model 336:** The GPIB address for the Model 336 temperature controller that is monitoring the magnet temperature. This should be the same address as used for the sample stage control. During field control, the driver will monitor the magnet temperature to ensure the magnet stays below 5.5 K.



Figure 9: Model 336 GPIB address

4. **Magnet Channel:** Active channel on the Model 336 temperature controller which is monitoring the magnet temperature. Depending on probe station configuration, this will be channel B or C.



Figure 10: Magnet Channel

V. EasyEXPERT™ Quick Test

The Quick Test is a fast and easy way to build an automated, variable temperature device measurement.

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ğ	Id-Vg GM(2)	(-)		1		
Test	Id-Va GM(3)	:(S)		1		
acer	Lake Shore 90K			1		
É	Id-Vg GM(4)			1	Up	
Test	Lake Shore 110K			1		
Ę	Id-Vg GM(5)			1	Down	
<u>~</u>	Id-Va GM(6)			1		
	Lake Shore 150K			1	Recall	
	Id-Vg GM(7)			1	Edit Burnet	
	Lake Shore 170K			1	Edit Repeat	
	Id-Vg GM(8)			1	Rename	
	Id-Va GM(9)			1		
	Lake Shore 210K			1	Duplicate	
	Id-Vg GM(10)			1	Delete	
	Lake Shore 230K			1		
	Id-Vg GM(11)			1	Unlock	
	Id-Va GM(12)			1	•	
•	Flag Setup Name	Date	Count	Device ID	Remarks	^
ults	Lake Shore 90K	12/14/2015 6:21:38 PM	2			
Res	Id-Vg GM(3)	12/14/2015 6:03:22 PM	2			
	Lake Shore 70K	12/14/2015 6:03:19 PM	2			-
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Figure 11: Quick Test

To build a Quick Test:

- 1. On the Model 336 driver screen, change the setpoint and other parameters as necessary.
- 2. Create a unique Setup Name.
- 3. Save the test. The test will be saved under My Favorite.

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Figure 12: Building a Quick Test

4. Use the Quick Test list tools to build your quick test protocol from the elements saved to My Favorite.

<u>F</u> ile	<u>E</u> dit	<u>V</u> iew	<u>R</u> un	Tools	<u>H</u> elp											
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Test	JI Id-	Va GM(3	3)								1					
Cer	Lak	e Shore	90K								1					1
Tra	Id-	Va GM(4	4)								1				Up	
sst	Lak	e Shore	110K								1					
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	al Id-	Vg GM(7	')					1								
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	Id-	Vg GM(9))								1			D	uplicate	
	Lak	e Shore	210K								1			_		
	10-	Vg GM(1	.0)								1				Delete	
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Initial \	Workspace					J. Th	ermometer OFF	Multi Displ	ay OFF	U	Standby OFF	▶0 SM	U Zero	OFF	Auto Exp	ort (

Figure 13: Quick Test list

VI.Service

The most direct and efficient means of contacting Lake Shore is to complete the online service request form at <u>http://www.lakeshore.com/service/Pages/default.aspx</u>. Provide a detailed description of the problem and the required contact information. You will receive a response within 24 hours, or the next business day in the event of weekends or holidays.

To contact Systems Service by mail or telephone:

Lake Shore Cryotronics, Inc. 575 McCorkle Blvd. Westerville, Ohio 43082 USA Phone: 614-891-2243 (option 6) Fax: 614-818-1608 e-mail: <u>sysservice@lakeshore.com</u>