STAR CRYOELECTRONICS

pcSQUID™

VERSATILE AND EASY-TO-USE SQUID INSTRUMENTATION!

STAR Cryoelectronics' family of advanced PC-based dc SQUID readout electronics, pcSQUID™, offers unsurpassed versatility and ease of use together with outstanding performance for both LTS and HTS dc SQUIDs. The modular single- and expandable multi-channel systems are designed to simplify integration into a wide range of user applications



SINGLE- AND MULTI-CHANNEL PROGRAMMABLE FEEDBACK LOOPS

The state-of-the-art PFL-100 Programmable Feedback Loop (PFL) offers unsurpassed performance and control functionality for single- and multi-channel applications. All SQUID signal levels are digitally controlled with high resolution by a computer. The user may remotely select dc bias or ac bias to minimize low- frequency noise intrinsic to some types of HTS SQUIDs. All readout techniques preserve wide-band operation. Two sensor coupling ranges and three closed-loop feedback ranges, all of which can be selected remotely, ensure optimum performance for a broad range of dc SQUID sensors. An external feedback input allows the implementation of sophisticated noise cancellation techniques. The compact and low-power design simplifies multi-channel and portable operation.



The multi-channel PFL-800 Programmable Feedback Loop contains eight independently programmable feedback loop channels in a single enclosure. Four feedback ranges are available along with optional auto-reset control for each channel. All drive signals and feedback loop parameters may be configured remotely via software for each channel. Each PFL-800 can control eight LTS SQUIDs, multiple PFL-800 units may be rack mounted in groups of twelve. The PFL-800 offers a cost effective, high-performance solution for large multi-channel applications.

The high-speed PFL-102 Programmable Feedback Loop offers wide bandwidth (>1 MHz) and high slew rate (>1 $M\Phi_0$/sec). The PFL-102 is designed to control two-stage SQUID amplifiers and includes two independent bias drive circuits, one for the voltage-biased low-noise input stage, one for the series SQUID array output stage. Two independent feedback circuits are available, allowing the feedback to be coupled to the input stage or the output stage for locked loop operation. All drive signals and feedback loop parameters may be configured remotely via software.

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SINGLE- AND MULTI-CHANNEL PC INTERFACE UNITS



Single- and multi-channel PC Interface (PCI) units are available for STAR Cryoelectronics' advanced Programmable Feedback Loops (PFLs). The PC Interface is controlled by a computer via optically isolated RS-232 or parallel ports. All digital control signals to the Programmable Feedback Loops are generated by a Serial Control Code transmitter in the PC Interface. The PCI-1000 can control up to eight PFL-100 or PFL-102 channels, while the low-cost PCI-100 is ideal for single-channel applications. The PCI-1800 is used to operate the multi-channel PFL-800 Programmable Feedback Loop. Each PCI may be configured for master/slave mode for applications requiring additional channels. The analog output signals from the Programmable Feedback Loops are available at the PC Interface via front-panel BNC connectors, either wideband or low-pass filtered with optional, user-selectable cutoff frequencies, or at a multi-pin connector on the rear panel (Models PCI-1000 and PCI-1800).



SQUID CONTROL SOFTWARE FOR WINDOWS™

STAR Cryoelectronics' PCS control software makes dc SQUID operation easy for the first-time user, yet allows the expert complete control over the full power and features of the Programmable Feedback Loop. The graphical user interface for Microsoft Windows™ displays multi-channel information at a glance, unlike conventional instruments that require scrolling through multiple menus. The control software for PC Interface Models PCI-100 and PCI-1000 and Programmable Feedback Loop Model PFL-100 is comprised of two modules, a SQUID Control Module and an optional Data Acquisition Module. The SQUID Control Module allows the user to configure each sensor channel individually for optimal performance. The bias current, modulation, skew and offset signal levels may be adjusted manually using the keyboard or mouse. With the optional Data Acquisition Module, an autotune function may be selected to quickly and automatically find the optimal operating point for a given sensor (using Model PCI-1000 only and requires optional Multi-Channel Data Acquisition package)

MULTI-CHANNEL DATA ACQUISITION PACKAGE FOR PCI-1000

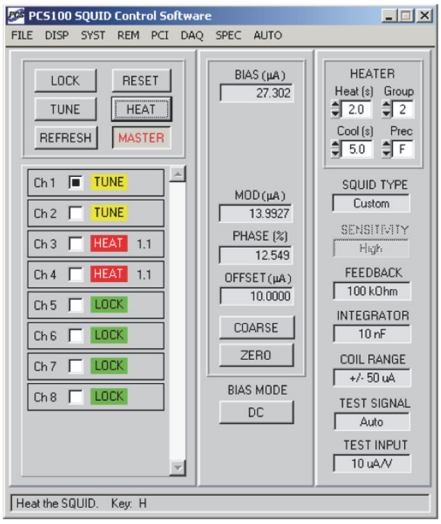
This optional package for the Model PCI-1000, consisting of a National Instruments PCI or PCIe 8-channel data acquisition board and the Data Acquisition Control Software Module, give you complete data acquisition capability. Multi-channel data may be streamed to a file and recalled later for viewing. Data outputs are available in both ASCII and binary formats.

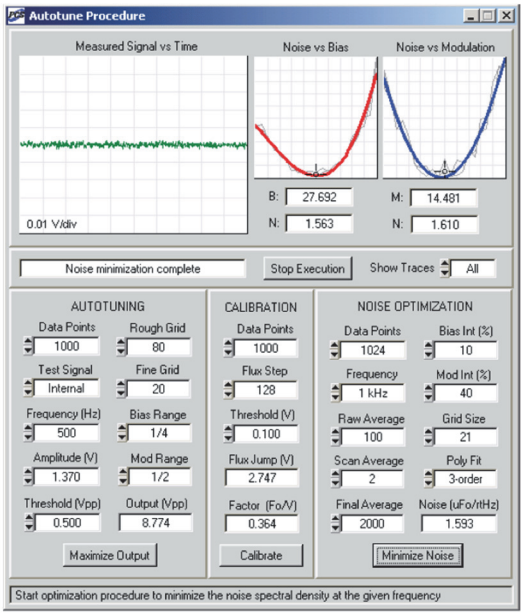
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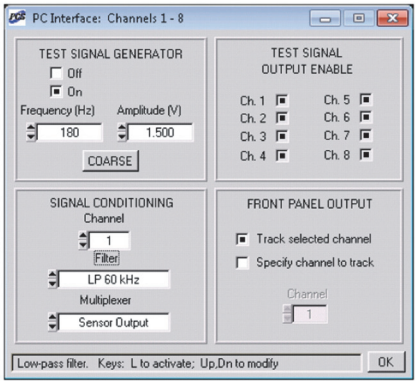
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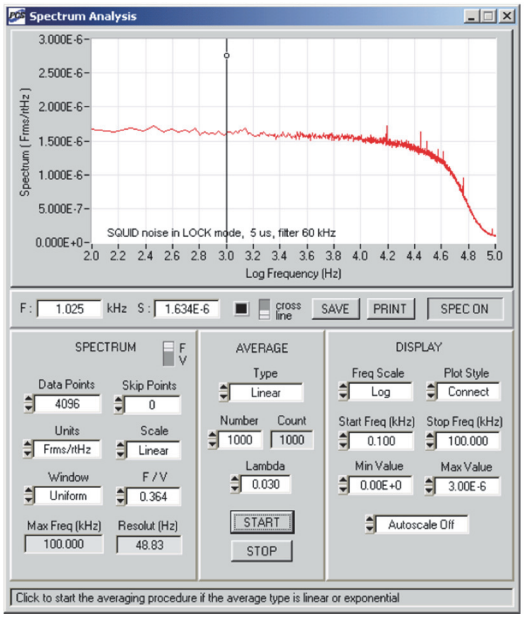
PCS100 CONTROL SOFTWARE FOR PCI-1000/PFL-100

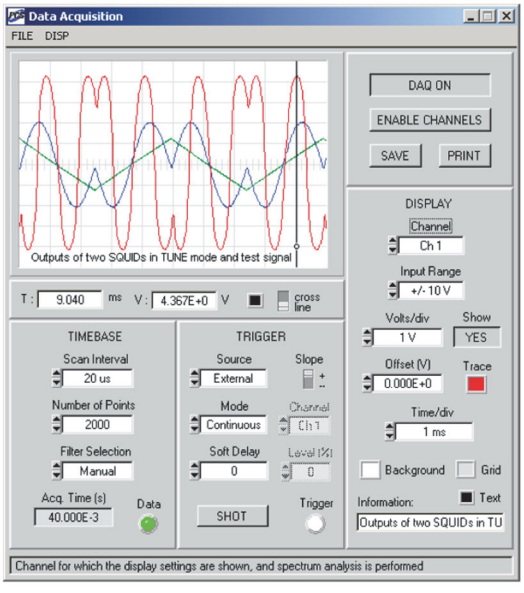






PCS100 Control Software with optional Data Acquisition Model. Includes Data Acquisition, Spectral Analysis, and Autune capabilities.





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READY FOR INTEGRATION!

STAR Cryoelectronics' family of advanced dc SQUIDs and PC-based SQUID instrumentation form a revolutionary modular system that is easily integrated into your application. The modular approach also makes it simple to upgrade your system as your measurement needs grow. Contact STAR Cryoelectronics today to discuss your particular applications and requirements.

STANDARD SYSTEM CONFIGURATIONS

The currently available standard system configurations are summarized in the table below. Each pcSQUID™ system configuration includes the required interconnecting cables for the electronics and the appropriate control software. Mating cryocables and SQUID sensors are available separately.

MODEL	PCI	PFL	DESCRIPTION
PC-100	PCI-100	PFL-100	Low-cost single-channel system for LTS, HTS SQUIDs
PC-102	PCI-100	PFL-102	High-speed, single-channel system for SQUID amplifiers
PC-1000	PCI-1000	PFL-100	Expandable multi-channel laboratory system
PC-1000A	-	PFL-100	Additional channel add-on package for PC-1000
PC-1000D	-	-	Data acquisition add-on package for PC-1000
PC-1800	PCI-1800	PFL-800	Multi-channel system for LTS SQUID applications

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SPECIFICATIONS

Programmable Feedback Loop Model PFL-100

PFL Operation	Remote control using proprietary Serial Control Code (SCC) 8-bit internally configurable hardware address; address 0 controls all PFLs Up to 255 channels may be controlled independently Master PFL can drive any number of Slave PFLs Each PFL self-recognizes Master or Slave mode
Sensor Types	LTS or HTS
Sensor Coupling	Single (warm) or Dual (warm plus cooled) input transformer options, set via internal hardware switch Bias current 0 - 200 μA DC or 0 - 200 μA_{p-p} AC; 1 part in 4096 resolution AC bias frequency: 2, 64, or 128 kHz; remotely configurable Remotely adjustable compensation minimizes AC bias noise peaks
Modulation	0 - 50 μA_{p-p}, 1 part in 4096 resolution, provided by internal oscillator Modulation Frequency: 256 kHz (for DC, 2 and 64 kHz AC Bias) 128 kHz (128 kHz AC Bias)
Skew	0 - 50 μA_{p-p}, 1 part in 4096 resolution
Feedback	Internal or External Two feedback coupling ranges, remotely configurable Three feedback modes for each coupling range, remotely configurable
Type I SQUIDs, nominal 5 μA/Φ_0 feedback coupling	±10 μA, HIGH Sensitivity Mode ±100 μA, MEDIUM Sensitivity Mode ±1 mA, LOW Sensitivity Mode
Type II SQUIDs, nominal 50 μA/ Φ_0 feedback coupling	±100 μA, HIGH Sensitivity Mode ±1 mA, MEDIUM Sensitivity Mode ±10 mA, LOW Sensitivity Mode
Integrator	10 μs, 100 μs, or 1 ms time constants, remotely configurable
Output	±10 V
Bandwidth	Up to 100 kHz depending on SQUID voltage swing
DC Offset	Two ranges for Type I and Type II sensor coupling, remotely configurable
Type I SQUIDs	±5 μA, 1 part in 8192 resolution 0.1 nA_{p-p} drift over 24 hours typical

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Type II SQUIDs	±50 μA, 1 part in 8192 resolution 1 nA_{p-p} drift over 24 hours typical
Test Signal Input	Differential; configurable for each channel 10 μA/V, 100 μA/V, 1000 μA/V, remotely configurable 10 mA maximum current, 10 kΩ input impedance
Heater Supply	100 mA current source for heater resistances up to 100 Ω
Power Requirements	±12 VDC, +72/-56 mA in quiescent mode +184/-56 mA with heater on
Size (W×H×D)	2.8 × 0.77 × 4.4 (in) (71 × 19.5 × 112 (mm))
Weight	0.33 lb (150 g)

PC Interface Models PCI-1000 and PCI-100

Specification	PCI-1000	PCI-100
No. of channels	1-8; master/slave mode supported	1; master/slave mode supported
Communications	From PC: RS-232 or parallel port To PFL: Serial Control Code	From PC: RS-232 or parallel port To PFL: Serial Control Code
Analog Outputs	±10 V buffered PFL output, wideband or filtered, remotely configurable	±10 V buffered PFL output, wideband or filtered
Test Signal	Input Front panel; differential, remotely selectable for each channel, ±10 V max., 50 Ω Rear panel; 8 differential, ±10 V max., 10 kΩ	Front panel; differential, ±10 V max., 50 Ω
Filters	Optional 6, 10, 20, and 60 kHz 4-pole Butterworth; four filters may be Installed for each channel	5 kHz, 4-pole Butterworth (standard)
Power Requirement	120 or 240 VAC (selectable), 50/60 Hz, 40W (excl. filters)	±12 VDC, +100/-71 mA quiescent mode, +212/-71 mA with heater on (includes PFL).External power source for 120 or 240 VAC incl.
Cable Length	At least 50 m to Programmable Feedback Loop	At least 50 m to Programmable Feedback Loop
Size	(W×H×D) 16.7 × 1.69 × 12.7 (in) (424 × 44 × 323 (mm))	8.31 × 1.69 × 6.7 (in) (211 × 44 × 171 (mm))
Weight	8.16 lb (3700 g)	1.62 lb (738 g)

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Programmable Feedback Loop Model PFL-102

PFL Operation	Remote control using STAR Cryoelectronics' Serial Control Code 8-bit remotely programmable address; address 0 controls all PFLs 8-bit internally configurable hardware address
Sensor Type	Two-Stage SQUID Amplifier with low-noise, voltage-biased input SQUID stage, series SQUID array output stage
SQUID Stage	
Bias	0 - 2 mA DC, 1 part in 4096 resolution
DC Flux Offset	0-70 μA, 1 part in 4096 resolution
Feedback	Designed for nominal 10 μA/Φ_0 feedback coupling Three feedback ranges, remotely configurable: ±10 μA, HIGH Sensitivity Mode ±100 μA, MEDIUM Sensitivity Mode ±1 mA, LOW Sensitivity Mode
Integrator	10 μs, 100 μs, or 1 ns time constants, remotely configurable
Test Signal Input	Differential; configurable for each channel ±1 mA, 10 kΩ input impedance
Array Stage	
Bias	0 – 100 μA DC, 1 part in 4096 resolution
DC Flux Offset	0-170 μA 1 part in 4096 resolution
Feedback	Designed for nominal 10 μA/Φ_0 feedback coupling Three feedback ranges, remotely configurable: ±10 μA, HIGH Sensitivity Mode ±100 μA, MEDIUM Sensitivity Mode ±1 mA, LOW Sensitivity Mode
Integrator	10 μs, 100 μs, or 1 ns time constants, remotely configurable
Test Signal Input	Differential; configurable for each channel ±100 μA, 10 kΩ input impedance
Output	±10 V
Bandwidth	Better than 1 MHz
Slew Rate	1 MΦ_0/sec (small signals)
Heater Supply	100 mA, voltage limited to +12 VDC
Size (W×H×D)	2.8 × 0.77 × 4.4 (in) (71 × 19.5 × 112 (mm))
Weight	0.34 lb (156 g)

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Programmable Feedback Loop Model PFL-800

No. of Channels	Eight independent SQUID channels, remotely controllable.
Remote Control	PC-based, proprietary Serial Control Code (SCC) interface 5-bit internally configurable hardware address Up to 28 eight-channel PFLs (224 SQUID channels) may be controlled independently
Sensor Types	LTS
SQUID Inputs	Via 68-pin SCSI connector
Input Coupling	Single (warm) or Dual (warm plus cooled) input transformer options, configurable via internal solder jumpers
Bias	0 – 160 μA DC, 1 part in 4096 resolution
Modulation	0 – 200 μA_{p-p}, 1 part in 4096 resolution, provided by internal 256 kHz generator referenced to external clock signal from PC Interface
Feedback	Internal or External
Ranges	Four feedback ranges, remotely configurable ±10 μA, HIGH Sensitivity Mode, max. 0.5 nA/°C drift ±100 μA, MEDIUM Sensitivity Mode, max. 5 nA/°C drift ±1 mA, LOW Sensitivity Mode, max. 50 nA/°C drift ±10 mA, COARSE Sensitivity Mode, max. 2 μA/°C drift
Integrator	5 μs, 50 μs, 500 μs, 5 ms time constants, remotely configurable
Reset	Via software or external TTL signal External reset time <5μsec Optional auto-reset function
DC Offset	160 μA, 1 part in 8192 resolution, max. 2.5 nA/°C drift 1 nAp-p drift over 24 hours typical.
Bandwidth	Up to 100 kHz depending on SQUID transfer coefficient dV/dΦ
SQUID Outputs	±10 V differential analog outputs for each channel
Test Signal Inputs	Differential; 1 mV/μA, 10 mV/μA, 100 mV/μA, 1V/μA, remotely configurable for each channel, 10 mA maximum current, 10 k Ω input impedance
Remote Interface I/O	Via 68-pin SCSI connector; includes all SQUID outputs, test signal inputs, SCC data, power, and grounds
Indicators	SCC DATA OK/Fault Status LEDs, Heater LED
Heater Supply	100 mA current source for heater resistances up to 75 Ω

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Power Requirements	+12 VDC, 436 mA (+100 mA per activated heater), -12 VDC, 376 mA, +5 VDC, 45 mA (+11 mA per activated heater)
Size	(W×H×D) 9.88 × 7 × 0.94 (inch) (251 × 178 × 24 (mm))
Weight	2.8 lb (1270 g)

PC Interface Model PCI-1800

No. of Channels	Supports one 8-Channel Model PFL-800 Programmable Feedback Loop
Clock	Internal generator provides clock signal for PFL Master/Slave mode supported to synchronize clock signal for multiple PFLs Slave PCI-1800 auto-recognizes slave mode
Communications	From PC: RS-232 or parallel port To PFL: STAR Cryoelectronics Serial Control Code
Analog Outputs	±10 V buffered PFL output Front panel BNC: Wideband or Filtered, remotely configurable for each channel Rear panel DB-25: Eight differential analog outputs for each SQUID channel, Wideband or Filtered, remotely configurable
Test Signal Input	Front panel BNC: Differential, remotely configurable for each channel, ±10 V max., 50 Ω Rear panel DB-25: Eight differential inputs for each SQUID channel, ±10 V max., 10 k Ω
Test Signal Generator	0 – 2 V_{p-p}, 50 – 5,000 Hz, remotely controllable
External Reset Inputs	TTL (HI resets feedback loop), via rear-panel DB-9 connector
Filters	6, 10, 20, 60 kHz plug-in 4-pole Butterworth per channel (optional)
Power Requirements	120 or 240 VAC (selectable), 50/60 Hz, 40W (excl. filters); or external battery
Cable Length	At least 5 m to Programmable Feedback Loop
Size	(W×H×D) 16.7 × 1.69 × 12.7 (in) (424 × 44 × 323 (mm))
Weight	7.8 lb (3545 g)

All specifications are subject to change without prior notice.

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Also Available from STAR Cryoelectronics

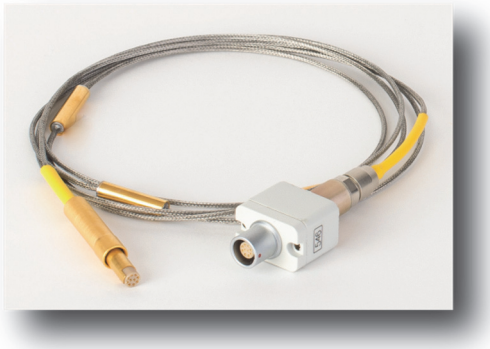
SQUID Sensors

- LTS series SQUID array amplifiers and integrated two-stage amplifiers
- LTS low inductance input SQUIDs for TES detector readout
- LTS integrated dc SQUID magnetometers with nom. 3 fT/Hz^{½} rms field noise
- LTS miniature integrated dc SQUID magnetometers with 0.5 mm OD pickup loops
- LTS vector magnetometers
- LTS axial and long-baseline planar gradiometers
- LTS series Josephson junction arrays and Q-Spoiler SQUID arrays
- LTS miniature dc SQUID susceptometers
- HTS magnetometers and gradiometers

Cryocables

- Woven loom and bundled twisted pairs, connectorized, with optional heat sinks





Foundry Services

- LTS and HTS, wafers up to 100-mm diameter

Cryogen-Free ADR Cryostats

- Cooling to <50 mK without liquid cryogens, <5 μKrms stability at 100 mK
- Configurable with TES microcalorimeter or STJ X-ray detector arrays, SQUID readouts, cryocables, custom IR filters

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