

Operation and Service Manual

# Diode Temperature Monitor

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**SIM922**



Stanford Research Systems

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Stanford Research Systems, Inc.  
1290-D Reamwood Avenue  
Sunnyvale, CA 94089 USA  
Phone: (408) 744-9040 • Fax: (408) 744-9049  
**www.thinkSRS.com • e-mail: info@thinkSRS.com**

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*SIM922 Diode Temperature Monitor*

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## General Information

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The SIM922 Diode Temperature Monitor, part of Stanford Research Systems' Small Instrumentation Modules family, consists of four channels of sensor excitation and readout for precision low-noise diode thermometry. Independent  $10\ \mu\text{A}$  DC current sources provide sensor excitations to the four-wire measurement circuits.

## Service

Do not install substitute parts or perform any unauthorized modifications to this instrument.

The SIM922 is a single-wide module designed to be used inside the SIM900 Mainframe. Do not turn on the power until the module is completely inserted into the mainframe and locked in place.

### Symbols you may Find on SRS Products

Symbol	Description
	Alternating current
	Caution - risk of electric shock
	Frame or chassis terminal
	Caution - refer to accompanying documents
	Earth (ground) terminal
	Battery
	Fuse
	On (supply)
	Off (supply)

## Notation

The following notation will be used throughout this manual:

- Front-panel buttons are set as [Button];  
[Adjust ▲▼] is shorthand for “[Adjust ▲] & [Adjust ▼]”.
- Front-panel indicators are set as *Overload*.
- Remote command names are set as \*IDN?
- Literal text other than command names is set as OFF.

## Specifications

### Performance Characteristics

		Min	Typ	Max	Units
Inputs	Number of inputs	4			
	Sensor type	Silicon diode			
	Measurement type	4-wire			
	Excitation	constant current			
Sensor Characteristics		9.999	10	10.001	$\mu\text{A DC}$ , $\pm 5 \text{ ppm}/^\circ\text{C}$
	Sensor units	Volts			
	Input Range	0		2.5	V
	sensor+lead resistance			1400	$\Omega$
	Calibration curves	1 built-in			
		4 user defined curves			
	Curve size (each)			256	points
	Temperature range	1.4		475	K (typical)
		sensor dependent			
	Measurement	Display resolution	4		
Interface resolution		1			$\mu\text{V}$
		1			mK
Measurement resolution			1.2		$\mu\text{V rms}$
Measurement accuracy, $(23 \pm 1)^\circ\text{C}$	$20 \mu\text{V} + 0.01 \%$				
Operating	Temperature coefficient	-5		+5	ppm/ $^\circ\text{C}$
	Temperature	0		40	$^\circ\text{C}$
	Power	$\pm 15, +5$			V DC
	Supply current	50 ( $\pm 15 \text{ V}$ ), 250 ( $+5 \text{ V}$ )			mA

### General Characteristics

Interface	Serial (RS-232) through SIM interface
Connectors	2 DB-9 (female)
	4-wire measurement + ground (Ch 1 & 2)
	4-wire measurement + ground (Ch 3 & 4)
	DB-15 (male) SIM interface
Weight	1.4 lbs
Dimensions	1.5" W $\times$ 3.6" H $\times$ 7.0" D



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# 1 Getting Started

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This chapter gives you the necessary information to get started quickly with the SIM922 Diode Temperature Monitor.

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## 1.1 Introduction to the Instrument

The SIM922 Diode Temperature Monitor monitors up to four (4) silicon diode thermometers using a precision  $10\ \mu\text{A}$  DC current excitation.

### 1.1.1 Overview

Each channel has an independent, precision  $10\ \mu\text{A}$  current source, so the excitation to the user's sensor remains steady as the SIM922 cycles between measurements. Disabling a channel switches that channel's current source off.

A precision 24-bit analog-to-digital converter is cycled between the channels with a rate of 4 conversions per second. With all channels enabled, a complete cycle is completed every second; disabling some channels yields a corresponding increase in overall cycle rate.

## 1.2 Front-Panel Operation

The front panel of the SIM922 (see Figure 1.1) provides a simple operator interface.



Figure 1.1: The SIM922 front and rear panels.

### 1.2.1 Excitation

The four channels of the SIM922 Diode Temperature Monitor can be independently enabled or disabled from the front panel. Disabling a channel turns off the  $10\ \mu\text{A}$  excitation current to that sensor, and speeds the readout rate for the remaining (enabled) channels.

To toggle the excitation for a channel, first briefly press [Excitation]. One of the four channel displays will appear highlighted, indicating which channel is selected. Briefly tap [Excitation] to advance the highlighted selection until the desired channel is selected. Then depress *and hold* [Excitation] until the display switches between the numerical value and the word *OFF*.

### 1.2.2 Units

The SIM922 displays the sensor results either as voltage (in millivolts) or temperature (in kelvin). Pressing [Units] toggles between these two modes; the active units are indicated by the illuminated *K* or *mV*.

When temperature units are selected, a sensor calibration curve is required. The SIM922 is preprogrammed with a standard curve for Si diode sensors. Each channel also has non-volatile memory to store a separate sensor curve with up to 256 temperature-vs-resistance points. The actual curve to use is selected with the remote interface CURV command.

## 1.3 Sensor Interface

The sensor interface on the SIM922 consists of two rear-panel DB-9/F connectors, labeled “CHANNELS 1 & 2” and “CHANNELS 3 & 4” (see Figure 1.1). Both connectors follow the same pinout, given in Table 1.1

Pin	Signal
1	I+, Ch 1(3)
2	I-, Ch 1(3)
3	ground
4	I+, Ch 2(4)
5	I-, Ch 2(4)
6	V+, Ch 1(3)
7	V-, Ch 1(3)
8	V+, Ch 2(4)
9	V-, Ch 2(4)

Table 1.1: SIM922 Sensor Interface Connector Pin Assignments, DB-9

### 1.3.1 Four-wire measurement

To avoid sensitivity to wiring lead resistance, the SIM922 is configured for four-wire measurements. The basic circuit for this wiring scheme is shown in Figure 1.2.

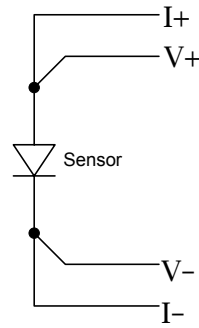


Figure 1.2: Wiring diagram for four-wire readout.

### 1.3.2 Two-wire measurement

If application-specific constraints limit the number of leads to the sensor, the SIM922 can be wired to measure the sensor resistance with a simple two-wire circuit, shown in Figure 1.3. Note that the lead resistance (past the junction points of the current and voltage leads) will add as a direct resistance error when measuring the sensor.

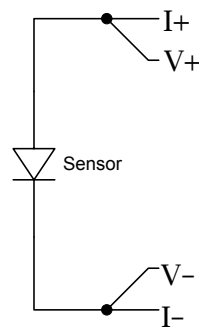


Figure 1.3: Wiring diagram for two-wire readout.

## 1.4 SIM Interface

The primary connection to the SIM922 Diode Temperature Monitor is the rear-panel DB-15 SIM interface connector. Typically, the SIM922 is mated to a SIM900 Mainframe via this connection, either through one of the internal mainframe slots, or the remote cable interface.

It is also possible to operate the SIM922 directly, without using the SIM900 Mainframe. This section provides details on the interface.



### CAUTION

*The SIM922 has no internal protection against reverse polarity, missing supply, or overvoltage on the power supply pins. Misapplication of power may cause circuit damage. SRS recommends using the SIM922 together with the SIM900 Mainframe for most applications.*

### 1.4.1 SIM interface connector

The DB-15 SIM interface connector carries all the power and communications lines to the instrument. The connector signals are specified in Table 1.2

Pin	Signal	Direction Src ⇒ Dest	Description
1	SIGNAL_GND	MF ⇒ SIM	Ground reference for signal
2	-STATUS	SIM ⇒ MF	Status/service request (GND=asserted, +5V=idle)
3	RTS	MF ⇒ SIM	HW Handshake (+5 V=talk; GND=stop)
4	CTS	SIM ⇒ MF	HW Handshake (+5 V=talk; GND=stop)
5	-REF_10MHZ	MF ⇒ SIM	10 MHz reference (optional connection)
6	-5V	MF ⇒ SIM	Power supply (No connection in SIM922)
7	-15V	MF ⇒ SIM	Power supply (analog circuitry)
8	PS_RTN	MF ⇒ SIM	Power supply return
9	CHASSIS_GND		Chassis ground
10	TXD	MF ⇒ SIM	Async data (start bit="0"=+5 V; "1"=GND)
11	RXD	SIM ⇒ MF	Async data (start bit="0"=+5 V; "1"=GND)
12	+REF_10MHz	MF ⇒ SIM	10 MHz reference (optional connection)
13	+5V	MF ⇒ SIM	Power supply (digital circuitry)
14	+15V	MF ⇒ SIM	Power supply (analog circuitry)
15	+24V	MF ⇒ SIM	Power supply (No connection in SIM922)

Table 1.2: SIM Interface Connector Pin Assignments, DB-15

### 1.4.2 Direct interfacing

The SIM922 is intended for operation in the SIM900 Mainframe, but users may wish to directly interface the module to their own systems without the use of additional hardware.

The mating connector needed is a standard DB-15 receptacle, such as Amp part # 747909-2 (or equivalent). Clean, well-regulated supply voltages of +5,  $\pm 15$  VDC must be provided, following the pin-out specified in Table 1.2. Ground must be provided on pins 1 and 8, with chassis ground on pin 9. The -STATUS signal may be monitored on pin 2 for a low-going TTL-compatible output indicating a status message.

#### 1.4.2.1 Direct interface cabling

If the user intends to directly wire the SIM922 independent of the SIM900 Mainframe, communication is usually possible by directly connecting the appropriate interface lines from the SIM922 DB-15 plug to the RS-232 serial port of a personal computer.<sup>1</sup> Connect RXD from the SIM922 directly to RD on the PC, TXD directly to TD, and similarly RTS→RTS and CTS→CTS. In other words, a null-modem style cable is *not* needed.

To interface directly to the DB-9 male (DTE) RS-232 port typically found on contemporary personal computers, a cable must be made with a female DB-15 socket to mate with the SIM922, and a female DB-9 socket to mate with the PC's serial port. Separate leads from the DB-15 need to go to the power supply, making what is sometimes know as a "hydra" cable. The pin-connections are given in Table 1.3.

DB-15/F to SIM922	Name
	DB-9/F
3 $\longleftrightarrow$ 7	RTS
4 $\longleftrightarrow$ 8	CTS
10 $\longleftrightarrow$ 3	TxD
11 $\longleftrightarrow$ 2	RxD
5	Computer Ground
	to P/S
7 $\longleftrightarrow$ -15 VDC	
14 $\longleftrightarrow$ +15 VDC	
13 $\longleftrightarrow$ +5 VDC	
8,9 $\longleftrightarrow$ Ground (P/S return current)	
1 $\longleftrightarrow$ Signal Ground (separate wire to Ground)	

Table 1.3: SIM922 Direct Interface Cable Pin Assignments

<sup>1</sup> Although the serial interface lines on the DB-15 do not satisfy the minimum voltage levels of the RS-232 standard, they are typically compatible with desktop personal computers

### 1.4.2.2 Serial settings

The initial serial port settings at power-on are: 9600 Baud, 8-bits, no parity, 1 stop bit, and RTS/CTS flow control. These may be changed with the BAUD, FLOW, or PARI commands.

The maximum *standard* baud rate that the SIM922 supports is 38400. The minimum baud rate is 110. Above 38400, the SIM922 can be set to the following (non-RS-232-standard) baud rates: 62500, 78125, 104167, 156250. Note that these rates are typically not accessible on a standard PC RS-232 port, but can be used between the SIM922 and the SIM900 Mainframe.





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## 2 Remote Operation

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This chapter describes operating the SIM922 over the serial interface.

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## 2.1 Index of Common Commands

symbol	definition
<i>i,j</i>	Integers
<i>f,g</i>	Floating-point values
<i>c</i>	Channel number (0–4); <i>c</i> =0 means “all”
<i>z</i>	Literal token
<i>s</i>	Arbitrary character sequence (no “,” or “;”)
(?)	Required for queries; illegal for set commands
<i>var</i>	Parameter always required
{ <i>var</i> }	Required parameter for set commands; illegal for queries
[ <i>var</i> ]	Optional parameter for both set and query forms

---

### Readout

VOLT? <i>c</i> [, <i>n</i> ]	2 – 9	Voltage Value
TVAL? <i>c</i> [, <i>n</i> ]	2 – 9	Temperature Value
SOUT	2 – 9	Stop Streaming

---

### Excitation

EXON(?) <i>c</i> {, <i>z</i> }	2 – 9	Excitation On/Off
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### Display & Configuration

DISX(?) { <i>z</i> }	2 – 10	Display Enable/Disable
DTEM(?) { <i>z</i> }	2 – 10	Display Temperature
FPLC(?) { <i>i</i> }	2 – 10	Frequency of Power Line Cycle

---

### Sensor Calibration

CINI(?) <i>c</i> {, <i>z</i> , <i>s</i> }	2 – 10	Initialize Sensor Calibration
CAPT <i>c,f,g</i>	2 – 11	Add User Curve Point
CAPT? <i>c,j</i>	2 – 11	Query User Curve Point
CURV(?) <i>c</i> {, <i>z</i> }	2 – 11	Select Sensor Curve

---

### Serial Communications

BAUD(?) { <i>i</i> }	2 – 11	Baud Rate
FLOW(?) { <i>z</i> }	2 – 12	Flow Control
PARI(?) { <i>z</i> }	2 – 12	Parity

---

### Status

*CLS	2 – 12	Clear Status
*STB? [ <i>i</i> ]	2 – 12	Status Byte
*SRE(?) [ <i>i</i> ,] { <i>j</i> }	2 – 12	Service Request Enable
*ESR? [ <i>i</i> ]	2 – 12	Standard Event Status
*ESE(?) [ <i>i</i> ,] { <i>j</i> }	2 – 12	Standard Event Status Enable

---

CESR? [i]	2-12 Communication Error Status
CESE(?) [i,]{j}	2-13 Communication Error Status Enable
OVSR? [i]	2-13 Overload Status
OVSE(?) [i,]{j}	2-13 Overload Status Enable
PSTA(?) {z}	2-13 Pulse -STATUS Mode

---

**Interface**

*RST	2-13 Reset
CONS(?) {z}	2-13 Console Mode
*IDN?	2-14 Identify
*OPC(?)	2-14 Operation Complete
LEXE?	2-14 Execution Error
LCME?	2-15 Device Error
LDDE?	2-15 Device Error
LBTN?	2-15 Button
TOKN(?) {z}	2-15 Token Mode
TERM(?) {z}	2-16 Response Termination

## 2.2 Alphabetic List of Commands

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### ★

*CLS	2 – 12	Clear Status
*ESE(?) [i,] {j}	2 – 12	Standard Event Status Enable
*ESR? [i]	2 – 12	Standard Event Status
*IDN?	2 – 14	Identify
*OPC(?)	2 – 14	Operation Complete
*RST	2 – 13	Reset
*SRE(?) [i,] {j}	2 – 12	Service Request Enable
*STB? [i]	2 – 12	Status Byte

---

### B

BAUD(?) {i}	2 – 11	Baud Rate
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### C

CAPT <i>c,f,g</i>	2 – 11	Add User Curve Point
CAPT? <i>c,j</i>	2 – 11	Query User Curve Point
CESE(?) [i,]{j}	2 – 13	Communication Error Status Enable
CESR? [i]	2 – 12	Communication Error Status
CINI(?) <i>c {,z,s}</i>	2 – 10	Initialize Sensor Calibration
CONS(?) {z}	2 – 13	Console Mode
CURV(?) <i>c {,z}</i>	2 – 11	Select Sensor Curve

---

### D

DISX(?) {z}	2 – 10	Display Enable/Disable
DTEM(?) {z}	2 – 10	Display Temperature

---

### E

EXON(?) <i>c {,z}</i>	2 – 9	Excitation On/Off
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---

### F

FLOW(?) {z}	2 – 12	Flow Control
FPLC(?) {i}	2 – 10	Frequency of Power Line Cycle

---

### L

LBTN?	2 – 15	Button
LCME?	2 – 15	Device Error
LDDE?	2 – 15	Device Error
LEXE?	2 – 14	Execution Error

---

### O

OVSE(?) [i,]{j}	2 – 13	Overload Status Enable
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---

---

OVSR? [i]            2-13 Overload Status

---

**P**

PARI(?) {z}            2-12 Parity

PSTA(?) {z}            2-13 Pulse -STATUS Mode

---

**S**

SOUT                    2-9 Stop Streaming

---

**T**

TERM(?) {z}            2-16 Response Termination

TOKN(?) {z}            2-15 Token Mode

TVAL? c [,n]           2-9 Temperature Value

---

**V**

VOLT? c [,n]           2-9 Voltage Value

## 2.3 Introduction

Remote operation of the SIM922 is through a simple command language documented in this chapter. Both set and query forms of most commands are supported, allowing the user complete control of the amplifier from a remote computer, either through the SIM900 Mainframe or directly via RS-232 (see Section 1.4.2.1).

See Table 1.2 for specification of the DB-15 SIM interface connector.

### 2.3.1 Power-on configuration

The settings for the remote interface are 9600 baud with no parity and hardware flow control, and local echo disabled (CONS OFF).

Most of the SIM922 instrument settings are stored in non-volatile memory, and at power-on the instrument returns to the state it was last in when power was removed. Exceptions are noted in the command descriptions.

Reset values of parameters are shown in **boldface**.

### 2.3.2 Buffers

Incoming data from the host interface is stored in a 32-byte input buffer. Characters accumulate in the input buffer until a command terminator (either <CR> or <LF>) is received, at which point the message is parsed and executed. Query responses from the SIM922 are buffered in a 64-byte output queue.

If the input buffer overflows, then all data in *both* the input buffer and the output queue are discarded, and an error is recorded in the CESR and ESR status registers.

### 2.3.3 Device Clear

The SIM922 host interface can be asynchronously reset to its power-on configuration by sending an RS-232-style <break> signal. From the SIM900 Mainframe, this is accomplished with the SRST command; if directly interfacing via RS-232, then use a serial break signal. After receiving the Device Clear, the interface is reset to 9600 baud and CONS mode is turned OFF. Note that this *only* resets the communication interface; the basic function of the SIM922 is left unchanged; to reset the instrument, see \*RST.

The Device Clear signal will also terminate any streaming outputs from the SIM922 due to a TVAL? or RVAL? query of multiple conversions.

## 2.4 Commands

This section provides syntax and operational descriptions for remote commands.

### 2.4.1 Command syntax

The four letter mnemonic (shown in **CAPS**) in each command sequence specifies the command. The rest of the sequence consists of parameters.

Commands may take either *set* or *query* form, depending on whether the “?” character follows the mnemonic. *Set only* commands are listed without the “?”, *query only* commands show the “?” after the mnemonic, and *optionally query* commands are marked with a “(?)”.

Parameters shown in { } and [ ] are not always required. Parameters in { } are required to set a value, and are omitted for queries. Parameters in [ ] are optional in both set and query commands. Parameters listed without any surrounding characters are always required.

Do *not* send ( ) or { } or [ ] as part of the command.

Multiple parameters are separated by commas. Multiple commands may be sent on one command line by separating them with semicolons (;) so long as the input buffer does not overflow. Commands are terminated by either <CR> or <LF> characters. Null commands and whitespace are ignored. Execution of command(s) does not begin until the command terminator is received.

tokens Token parameters (generically shown as *z* in the command descriptions) can be specified either as a keyword or integer value. Command descriptions list the valid keyword options, with each keyword followed by its corresponding integer value. For example, to set the response termination sequence to <CR>+<LF>, the following two commands are equivalent:

TERM CRLF —or— TERM 3

For queries that return token values, the return format (keyword or integer) is specified with the TOKN command.

## 2.4.2 Notation

The following table summarizes the notation used in the command descriptions:

symbol	definition
<i>i,j</i>	Integers
<i>f,g</i>	Floating-point values
<i>c</i>	Channel number (0–4); <i>c</i> =0 means “all”
<i>z</i>	Literal token
<i>s</i>	Arbitrary character sequence (no “,” or “;”)
(?)	Required for queries; illegal for set commands
<i>var</i>	Parameter always required
{ <i>var</i> }	Required parameter for set commands; illegal for queries
[ <i>var</i> ]	Optional parameter for both set and query forms



### 2.4.3 Readout commands

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VOLT? <i>c</i> [, <i>n</i> ]	<p>Voltage Value</p> <p>Query the sensor voltage for channel <i>c</i>.</p> <p>If <i>c</i>=0, then all four channels are returned in the format: &lt;<i>c</i>1&gt;, &lt;<i>c</i>2&gt;, &lt;<i>c</i>3&gt;, &lt;<i>c</i>4&gt;.</p> <p>If the optional parameter <i>n</i> is provided, then <i>n</i> sequential conversion results are returned to the host. If <i>n</i>=0, the conversion results continue indefinitely. To terminate the stream before <i>n</i> results (or when <i>n</i>=0), issue the SOUT command.</p> <p>Note that omitting <i>n</i> is equivalent to <i>n</i>=1.</p>
TVAL? <i>c</i> [, <i>n</i> ]	<p>Temperature Value</p> <p>Query the sensor temperature value for channel <i>c</i>.</p> <p>If <i>c</i>=0, then all four channels are returned in the format: &lt;<i>c</i>1&gt;, &lt;<i>c</i>2&gt;, &lt;<i>c</i>3&gt;, &lt;<i>c</i>4&gt;.</p> <p>If the optional parameter <i>n</i> is provided, then <i>n</i> sequential conversion results are returned to the host. If <i>n</i>=0, the conversion results continue indefinitely. To terminate the stream before <i>n</i> results (or when <i>n</i>=0), issue the SOUT command.</p> <p>Note that omitting <i>n</i> is equivalent to <i>n</i>=1.</p>
SOUT	<p>Stop Streaming</p> <p>Turn off streaming output.</p>

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### 2.4.4 Excitation commands

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EXON(?) <i>c</i> {, <i>z</i> }	<p>Excitation On/Off</p> <p>Set (query) the Channel <i>c</i> excitation current {to <i>z</i>=(OFF 0, ON 1)}.</p> <p>If <i>c</i>=0, then all four channel excitation states are set (queried).</p>
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### 2.4.5 Display & configuration commands

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DISX(?) {z}	<p>Display Enable/Disable</p> <p>Set (query) the front panel display {to z=(OFF 0, ON 1)}.</p> <p>The DISX setting is <i>not</i> stored in non-volatile memory. At power-on, the SIM922 returns to DISX ON.</p>
DTEM(?) {z}	<p>Display Temperature</p> <p>Set (query) the display temperature mode {to z=(OFF 0, ON 1)}.</p> <p>If DTEM OFF, then results are displayed in ohms; otherwise, results are displayed in kelvin.</p>
FPLC(?) {i}	<p>Frequency of Power Line Cycle</p> <p>Set (query) the power line rejection frequency {to j=(50, 60)}, in Hz.</p>

---

### 2.4.6 Sensor calibration commands

In addition to the built-in curve, each channel has a dedicated 256-point non-volatile memory for storing user calibration curves. Once loaded, these curves are retained by the SIM922 through power cycles.

---

CINI(?) c {,z,s}	<p>Initialize Sensor Calibration</p> <p>Initialize sensor calibration curve for channel <i>c</i>.</p> <p>The set form of the command, CINI <i>c,z,s</i>, erases the old curve for channel <i>c</i>. The second parameter <i>z</i> specifies the curve format, as one of:</p> <table style="margin-left: 40px;"> <thead> <tr> <th style="border-right: 1px solid black; padding: 2px 10px;"><i>z</i></th> <th style="padding: 2px 10px;">meaning</th> </tr> </thead> <tbody> <tr> <td style="border-right: 1px solid black; padding: 2px 10px;">LINEAR 0</td> <td style="padding: 2px 10px;">volts, kelvin</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px 10px;">SEMILOGT 1</td> <td style="padding: 2px 10px;">volts, log<sub>10</sub>(kelvin)</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px 10px;">SEMILOGV 2</td> <td style="padding: 2px 10px;">log<sub>10</sub>(volts), kelvin</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 2px 10px;">LOGLOG 3</td> <td style="padding: 2px 10px;">log<sub>10</sub>(volts), log<sub>10</sub>(kelvin)</td> </tr> </tbody> </table>	<i>z</i>	meaning	LINEAR 0	volts, kelvin	SEMILOGT 1	volts, log <sub>10</sub> (kelvin)	SEMILOGV 2	log <sub>10</sub> (volts), kelvin	LOGLOG 3	log <sub>10</sub> (volts), log <sub>10</sub> (kelvin)
<i>z</i>	meaning										
LINEAR 0	volts, kelvin										
SEMILOGT 1	volts, log <sub>10</sub> (kelvin)										
SEMILOGV 2	log <sub>10</sub> (volts), kelvin										
LOGLOG 3	log <sub>10</sub> (volts), log <sub>10</sub> (kelvin)										

The third parameter *s* is an arbitrary identification string for this sensor calibration curve. This string can consist of any non-blank characters *except* the comma “,” or semicolon “;”, and can be up to 15 characters in length.

The query form of the command, CINI? *c*, returns the following response:

⟨format⟩, ⟨serial⟩, *n*

where ⟨format⟩ is the calibration curve format (same as *z* above), ⟨serial⟩ is the identification string (*s* above), and *n* is the number of

points currently stored in the curve.

---

CAPT *c,f,g*

Add User Curve Point

Add a new point to the channel *c* user curve. *f* is the raw sensor value (in either volts or  $\log_{10}(\text{volts})$ , depending on curve format), and *g* is the corresponding temperature value (in either kelvin or  $\log_{10}(\text{kelvin})$ , again depending on curve format).

Note that curve points *must* be added in increasing order of sensor value *f*.

---

CAPT? *c,j*

Query User Curve Point

Query the value of the channel *c* user curve, entry point *j*.

The response is

$\langle \text{sensor} \rangle, \langle \text{temperature} \rangle,$

where  $\langle \text{sensor} \rangle$  is the raw sensor value (in either volts or  $\log_{10}(\text{volts})$ , depending on curve format), and  $\langle \text{temperature} \rangle$  is the corresponding temperature value (in either kelvin or  $\log_{10}(\text{kelvin})$ , again depending on curve format).

---

CURV(?) *c {,z}*

Select Sensor Curve

Set (query) the sensor curve selection for channel *c* {to *z*=(**STAN 0**, **USER 1**)}.

If *c*=0, all four channels are set (queried).

The built-in standard curve is selected by *z*=**STAN**. When **CURV USER** is selected, the user calibration curve (previously loaded with **CINI** and **CAPT**) is used.

### 2.4.7 Serial communication commands

---

BAUD(?) {*i*}

Baud Rate

Set (query) the baud rate {to *i*}.

At power-on, the baud rate defaults to 9600.

Actual baud rate settings depend on implementation details of the SIM922, based on modulo prescalars of the 10 MHz system clock. As a result, queries of **BAUD?** will in general be slightly different from the set values. For example, after setting **BAUD 9600**, the query **BAUD?** will respond **9470**. The functional requirement for successful asynchronous serial communication is no greater than ~ 5 % mismatch in baud rates.

---

FLOW(?) {z}	Flow Control Set (query) flow control {to z=(NONE 0, RTS 1, XON 2)}. At power-on, the SIM922 defaults to FLOW RTS flow control.
PARI(?) {z}	Parity Set (query) parity {to z = (NONE 0, ODD 1, EVEN 2, MARK 3, SPACE 4)}. At power-on, the SIM922 defaults to PARI NONE.

---

### 2.4.8 Status commands

The Status commands query and configure registers associated with status reporting of the SIM922. See Section 2.5 for more details.

---

*CLS	Clear Status *CLS immediately clears the ESR, CESR, and the OVSR.
*STB? [i]	Status Byte Reads the Status Byte register [bit <i>i</i> ]. Execution of the *STB? query (without the optional bit <i>i</i> ) always causes the –STATUS signal to be deasserted. Note that *STB? <i>i</i> will <i>not</i> clear –STATUS, even if bit <i>i</i> is the only bit presently causing the –STATUS signal.
*SRE(?) [i.] {j}	Service Request Enable Set (query) the Service Request Enable register [bit <i>i</i> ] {to <i>j</i> }.
*ESR? [i]	Standard Event Status Reads the Standard Event Status Register [bit <i>i</i> ]. Upon executing *ESR?, the returned bit(s) of the ESR register are cleared.
*ESE(?) [i.] {j}	Standard Event Status Enable Set (query) the Standard Event Status Enable Register [bit <i>i</i> ] {to <i>j</i> }.
CESR? [i]	Communication Error Status Query Communication Error Status Register [for bit <i>i</i> ]. Upon executing a CESR? query, the returned bit(s) of the CESR register are cleared.

---

---

CESE(?) [i,]j}	<p>Communication Error Status Enable</p> <p>Set (query) Communication Error Status Enable Register [bit <i>i</i>] {to <i>j</i>}.</p>
OVSR? [i]	<p>Overload Status</p> <p>Query Overload Status Register [for bit <i>i</i>].</p> <p>Upon executing a OVSR? query, the returned bit(s) of the OVSR register are cleared.</p>
OVSE(?) [i,]j}	<p>Overload Status Enable</p> <p>Set (query) Overload Status Enable Register [bit <i>i</i>] {to <i>j</i>}.</p>
PSTA(?) {z}	<p>Pulse –STATUS Mode</p> <p>Set (query) the Pulse –STATUS Mode {to z=(OFF 0, ON 1)}.</p> <p>When PSTA ON is set, any new service request will only <i>pulse</i> the –STATUS signal low (for a minimum of 1 <math>\mu</math>s). The default behavior is to latch –STATUS low until a *STB? query is received.</p> <p>At power-on, PSTA is set to OFF.</p>

---

### 2.4.9 Interface commands

---

*RST	<p>Reset</p> <p>Reset the SIM922 to default configuration.</p> <p>The following commands are internally executed upon *RST:</p> <ul style="list-style-type: none"> <li>• EXON 0, ON</li> <li>• CURV 0, STAN</li> <li>• DTEM ON</li> <li>• SOUT</li> <li>• DISX ON</li> </ul>
CONS(?) {z}	<p>Console Mode</p> <p>Set (query) the Console mode {to z=(OFF 0, ON 1)}.</p> <p>CONS causes each character received at the Input Buffer to be copied to the Output Queue.</p> <p>At power-on and Device-Clear, CONS is set to OFF.</p>

---

---

*IDN?	<p>Identify</p> <p>Read the device identification string.</p> <p>The identification string is formatted as:  Stanford_Research_Systems,SIM922,s/n*****,ver#.#  where ***** is the 6-digit serial number, and #.# is the firmware revision level.</p>																		
*OPC(?)	<p>Operation Complete</p> <p>Operation Complete. Sets the OPC flag in the ESR register.</p> <p>The query form *OPC? writes a 1 in the output queue when complete, but does not affect the ESR register.</p>																		
LEXE?	<p>Execution Error</p> <p>Query the last execution error code. Valid codes are:</p> <table border="1" data-bbox="560 907 1166 1247"> <thead> <tr> <th>Value</th> <th>Definition</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>No execution error since last LEXE?</td> </tr> <tr> <td>1</td> <td>Illegal value</td> </tr> <tr> <td>2</td> <td>Wrong token</td> </tr> <tr> <td>3</td> <td>Invalid bit</td> </tr> <tr> <td>16</td> <td>Uninitialized curve</td> </tr> <tr> <td>17</td> <td>Curve full</td> </tr> <tr> <td>18</td> <td>Curve point out-of-order</td> </tr> <tr> <td>19</td> <td>Curve point past end</td> </tr> </tbody> </table>	Value	Definition	0	No execution error since last LEXE?	1	Illegal value	2	Wrong token	3	Invalid bit	16	Uninitialized curve	17	Curve full	18	Curve point out-of-order	19	Curve point past end
Value	Definition																		
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1	Illegal value																		
2	Wrong token																		
3	Invalid bit																		
16	Uninitialized curve																		
17	Curve full																		
18	Curve point out-of-order																		
19	Curve point past end																		

---

LCME?

Device Error

Query the last command error code. Valid codes are:

Value	Definition
0	No command error since last LCME?
1	Illegal command
2	Undefined command
3	Illegal query
4	Illegal set
5	Missing parameter(s)
6	Extra parameter(s)
7	Null parameter(s)
8	Parameter buffer overflow
9	Bad floating-point
10	Bad integer
11	Bad integer token
12	Bad token value
13	Bad hex block
14	Unknown token

LDDE?

Device Error

Query the last device error code. The only valid code is:

1 — Curve Erased

LBTN?

Button

Query the last button-press code. Valid codes are:

Value	Definition
0	no button pressed since last query
1	[Units]
2	[Excitation]

TOKEN(?) {z}

Token Mode

Set (query) the Token Query mode {to z=(OFF 0, ON 1)}.

If TOKEN ON is set, then queries to the SIM922 that return tokens will return the text keyword; otherwise they return the decimal integer value.

Thus, the only possible responses to the TOKEN? query are ON and 0.

At power-on, TOKN OFF is set.

---

TERM(?) {z}

Response Termination

Set (query) the <term> sequence {to z=(NONE 0, CR 1, LF 2, **CRLF 3**, LFCR 4)}.

The <term> sequence is appended to all query responses sent by the module, and is constructed of ASCII character(s) 13 (carriage return) and/or 10 (line feed).

At power-on, TERM CRLF is set.



## 2.5 Status Model

The SIM922 status registers follow the hierarchical IEEE–488.2 format. A block diagram of the status register array is given in Figure 2.1.

There are two categories of registers in the SIM922 status model:

- Event Registers : These read-only registers record the occurrence of defined events. When the event occurs, the corresponding bit is set to 1. Upon querying an event register, any set bits within it are cleared. These are sometimes known as “sticky bits,” since once set, a bit can only be cleared by reading its value. Event register names end with SR.
- Enable Registers : These read/write registers define a bitwise mask for their corresponding event register. If any bit position is set in an event register while the same bit position is also set in the enable register, then the corresponding summary bit message is set. Enable register names end with SE.

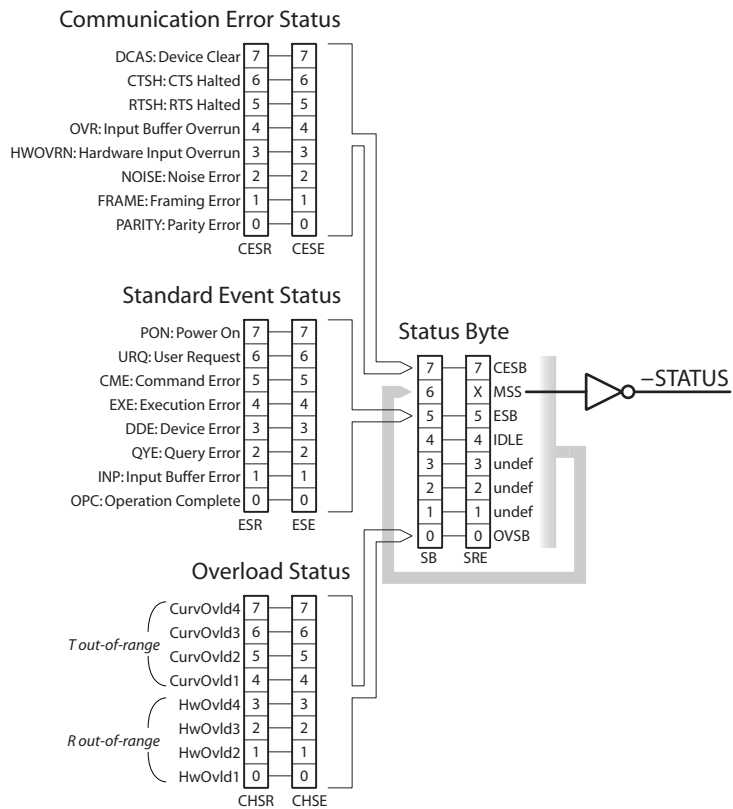


Figure 2.1: Status Register Model for the SIM922 Diode Temperature Monitor.

### 2.5.1 Status Byte (SB)

The Status Byte is the top-level summary of the SIM922 status model. When masked by the Service Request Enable register, a bit set in the Status Byte causes the  $\text{-STATUS}$  signal to be asserted on the rear-panel SIM interface connector.

Typically,  $\text{-STATUS}$  remains asserted (low) until a  $\text{*STB?}$  query is received, at which time  $\text{-STATUS}$  is deasserted (raised)<sup>1</sup>. After clearing the  $\text{-STATUS}$  signal, it will only be re-asserted in response to a *new* status-generating condition.

Weight	Bit	Flag
1	0	OVSB
2	1	undef (0)
4	2	undef (0)
8	3	undef (0)
16	4	IDLE
32	5	ESB
64	6	MSS
128	7	CESB

**OVSB :** Overload Status Summary Bit. Indicates whether one or more of the enabled flags in the Overload Status Register has become true.

**IDLE :** Indicates that the Input Buffer is empty and the command parser is idle. Can be used to help synchronize SIM922 query responses.

**ESB :** Event Status Bit. Indicates whether one or more of the enabled events in the Standard Event Status Register is true.

**MSS :** Master Summary Status. Indicates whether one or more of the enabled status messages in the Status Byte register is true. Note that while  $\text{-STATUS}$  is released by the  $\text{*STB?}$  query, MSS is only cleared when the underlying enabled bit message(s) are cleared.

**CESB :** Communication Error Summary Bit. Indicates whether one or more of the enabled flags in the Communication Error Status Register has become true.

Bits in the Status Byte are *not* cleared by the  $\text{*STB?}$  query. These bits are only cleared by reading the underlying event registers, or by clearing the corresponding enable registers.

<sup>1</sup> but see the PSTA command

### 2.5.2 Service Request Enable (SRE)

Each bit in the SRE corresponds one-to-one with a bit in the SB register, and acts as a bitwise AND of the SB flags to generate the MSS bit in the SB and the  $\text{-STATUS}$  signal. Bit 6 of the SRE is undefined—setting it has no effect, and reading it always returns 0. This register is set and queried with the `*SRE(?)` command.

This register is cleared at power-on.

### 2.5.3 Standard Event Status (ESR)

The Standard Event Status register consists of 8 event flags. These event flags are all “sticky bits” that are set by the corresponding event, and cleared only by reading or with the `*CLS` command. Reading a single bit (with the `*ESR? i` query) clears only bit  $i$ .

Weight	Bit	Flag
1	0	OPC
2	1	INP
4	2	QYE
8	3	DDE
16	4	EXE
32	5	CME
64	6	URQ
128	7	PON

OPC : Operation Complete. Set by the `*OPC` command.

INP : Input Buffer Error. Indicates data has been discarded from the Input Buffer.

QYE : Query Error. Indicates data in the Output Queue has been lost.

DDE : Device Dependent Error. Indicates a SIM922 had a delayed execution error, due to an illegal mode state. The error code can be queried with `LDDE?`.

EXE : Execution Error. Indicates an error in a command that was successfully parsed. Out-of-range parameters are an example. The error code can be queried with `LEXE?`.

CME : Command Error. Indicates a parser-detected error. The error code can be queried with `LCME?`.

URQ : User Request. Indicates a front-panel button was pressed.

PON : Power On. Indicates that an off-to-on transition has occurred

### 2.5.4 Standard Event Status Enable (ESE)

The ESE acts as a bitwise AND with the ESR register to produce the single bit ESB message in the Status Byte Register (SB). It can be set and queried with the \*ESE(?) command.

This register is cleared at power-on.

### 2.5.5 Communication Error Status (CESR)

The Communication Error Status register consists of 8 event flags; each of which is set by the corresponding event, and cleared only by reading or with the \*CLS command. Reading a single bit (with the CESR? *i* query) clears only bit *i*.

Weight	Bit	Flag
1	0	PARITY
2	1	FRAME
4	2	NOISE
8	3	HWOVRN
16	4	OVR
32	5	RTSH
64	6	CTSH
128	7	DCAS

PARITY : Parity Error. Set by serial parity mismatch on incoming data byte.

FRAME : Framing Error. Set when an incoming serial data byte is missing the STOP bit.

NOISE : Noise Error. Set when an incoming serial data byte does not present a steady logic level during each asynchronous bit-period window.

HWOVRN : Hardware Overrun. Set when an incoming serial data byte is lost due to internal processor latency. Causes the Input Buffer to be flushed, and resets the command parser.

OVR : Input Buffer Overrun. Set when the Input Buffer is overrun by incoming data. Causes the Input Buffer to be flushed, and resets the command parser.

RTSH : Undefined for the SIM922. Command Error. Indicates a parser-detected error.

CTSH : Undefined for the SIM922.

DCAS : Device Clear. Indicates the SIM922 received the Device Clear signal (an RS-232 <break>). Clears the Input Buffer and Output Queue, and resets the command parser.

### 2.5.6 Communication Error Status Enable (CESE)

The CESE acts as a bitwise AND with the CESR register to produce the single bit CESB message in the Status Byte Register (SB). It can be set and queried with the CESE(?) command.

This register is cleared at power-on.

### 2.5.7 Overload Status (OVSR)

The Overload Status register consists of 8 event flags; each of which is set by the corresponding event, and cleared only by reading or with the \*CLS command. Reading a single bit (with the OVSR? *i* query) clears only bit *i*.

Weight	Bit	Flag
1	0	HwOvld1
2	1	HwOvld2
4	2	HwOvld3
8	3	HwOvld4
16	4	CurvOvld1
32	5	CurvOvld2
64	6	CurvOvld3
128	7	CurvOvld4

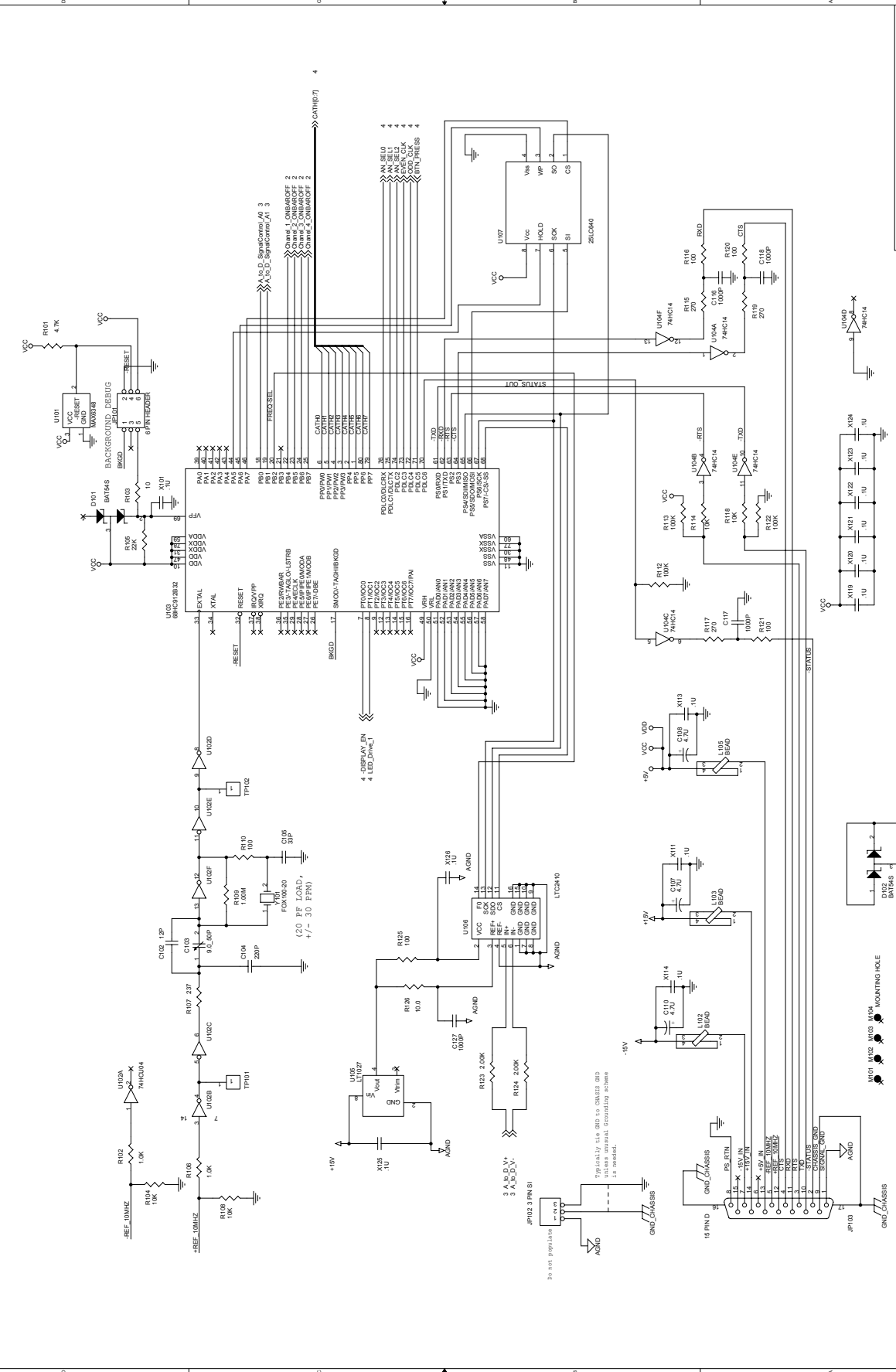
HwOvld $n$  : Hardware Overload. Indicates channel  $n$  resistance measured in excess of  $\sim 1500\ \Omega$ .

CurvOvld $n$  : Curve Out-of-range. Indicates channel  $n$  resistance measurement falls outside the bounds of the selected calibration curve.

### 2.5.8 Channel Status Enable (OVSE)

The OVSE acts as a bitwise AND with the OVSR register to produce the single bit OVSB message in the Status Byte Register (SB). It can be set and queried with the OVSE(?) command.

This register is cleared at power-on.

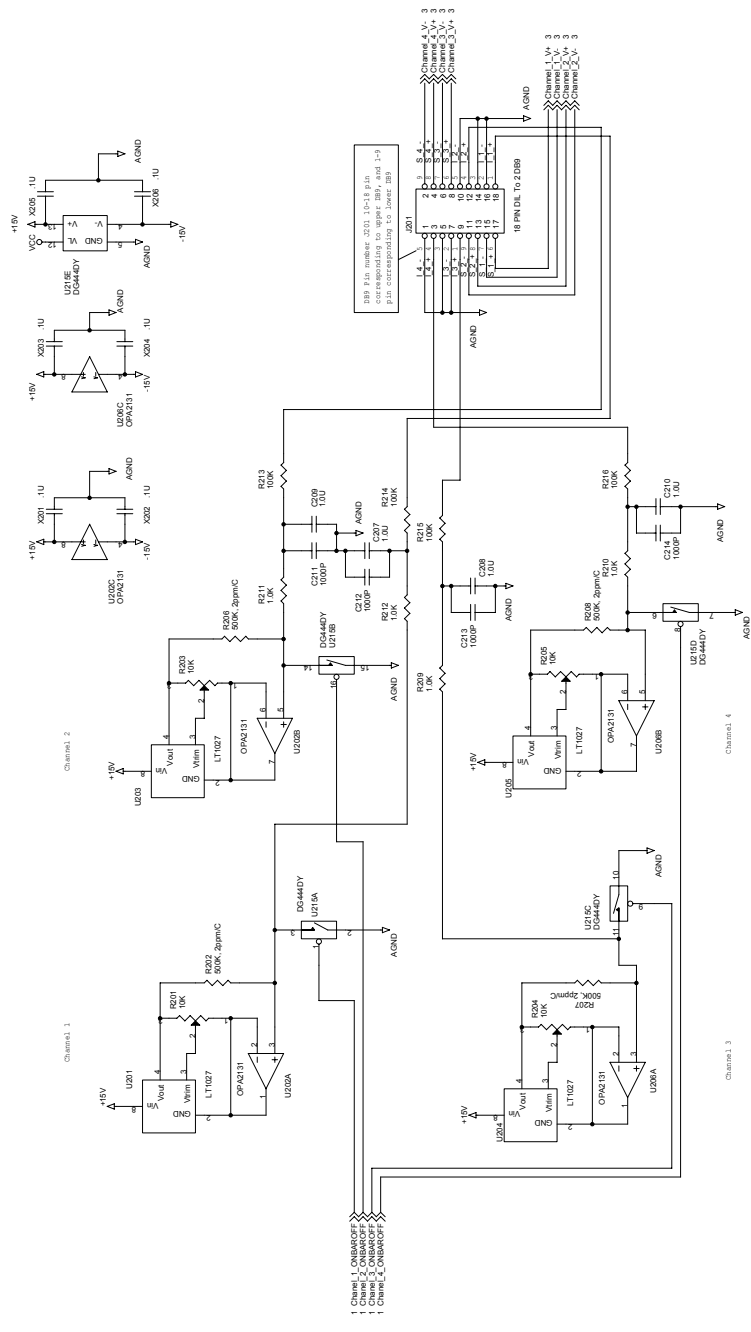


Pinout table for the microcontroller (U103).

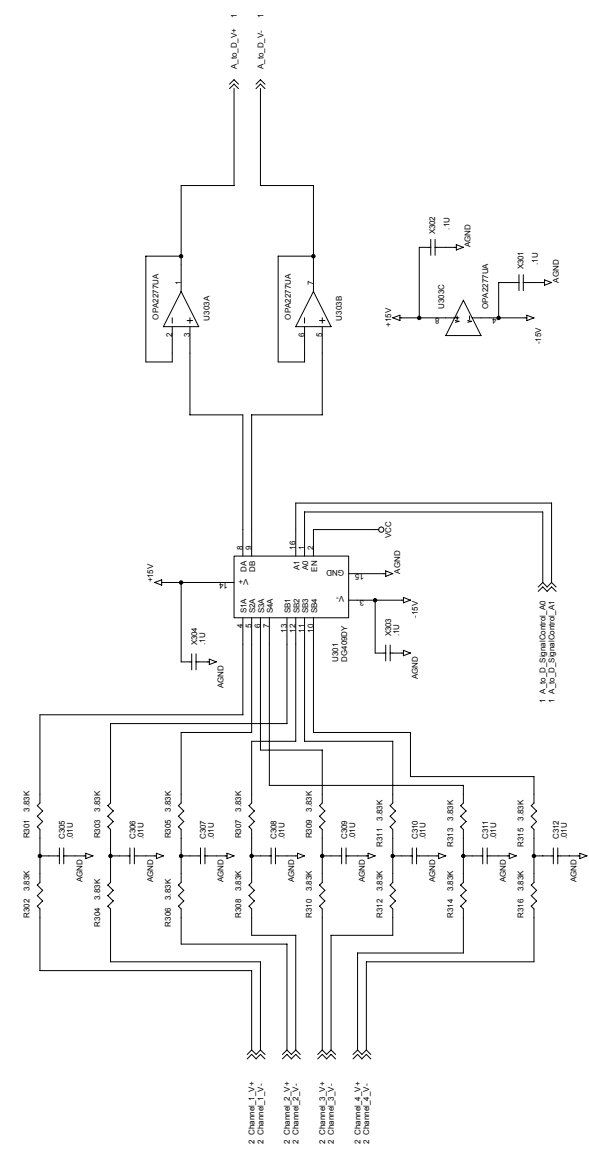
PA1	SignalControl_A0
PA2	SignalControl_A1
PA3	SignalControl_A2
PA4	SignalControl_A3
PA5	SignalControl_A4
PA6	SignalControl_A5
PA7	SignalControl_A6
PA8	SignalControl_A7
PA9	SignalControl_A8
PA10	SignalControl_A9
PA11	SignalControl_A10
PA12	SignalControl_A11
PA13	SignalControl_A12
PA14	SignalControl_A13
PA15	SignalControl_A14
PA16	SignalControl_A15
PA17	SignalControl_A16
PA18	SignalControl_A17
PA19	SignalControl_A18
PA20	SignalControl_A19
PA21	SignalControl_A20
PA22	SignalControl_A21
PA23	SignalControl_A22
PA24	SignalControl_A23
PA25	SignalControl_A24
PA26	SignalControl_A25
PA27	SignalControl_A26
PA28	SignalControl_A27
PA29	SignalControl_A28
PA30	SignalControl_A29
PA31	SignalControl_A30
PA32	SignalControl_A31
PA33	SignalControl_A32
PA34	SignalControl_A33
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PA36	SignalControl_A35
PA37	SignalControl_A36
PA38	SignalControl_A37
PA39	SignalControl_A38
PA40	SignalControl_A39
PA41	SignalControl_A40
PA42	SignalControl_A41
PA43	SignalControl_A42
PA44	SignalControl_A43
PA45	SignalControl_A44
PA46	SignalControl_A45
PA47	SignalControl_A46
PA48	SignalControl_A47
PA49	SignalControl_A48
PA50	SignalControl_A49
PA51	SignalControl_A50
PA52	SignalControl_A51
PA53	SignalControl_A52
PA54	SignalControl_A53
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PA56	SignalControl_A55
PA57	SignalControl_A56
PA58	SignalControl_A57
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PA61	SignalControl_A60
PA62	SignalControl_A61
PA63	SignalControl_A62
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PA80	SignalControl_A79
PA81	SignalControl_A80
PA82	SignalControl_A81
PA83	SignalControl_A82
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PA85	SignalControl_A84
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PA99	SignalControl_A98
PA100	SignalControl_A99
PA101	SignalControl_A100
PA102	SignalControl_A101
PA103	SignalControl_A102
PA104	SignalControl_A103
PA105	SignalControl_A104
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PA121	SignalControl_A120
PA122	SignalControl_A121
PA123	SignalControl_A122
PA124	SignalControl_A123
PA125	SignalControl_A124
PA126	SignalControl_A125
PA127	SignalControl_A126
PA128	SignalControl_A127
PA129	SignalControl_A128
PA130	SignalControl_A129
PA131	SignalControl_A130
PA132	SignalControl_A131
PA133	SignalControl_A132
PA134	SignalControl_A133
PA135	SignalControl_A134
PA136	SignalControl_A135
PA137	SignalControl_A136
PA138	SignalControl_A137
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PA179	SignalControl_A178
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PA181	SignalControl_A180
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PA184	SignalControl_A183
PA185	SignalControl_A184
PA186	SignalControl_A185
PA187	SignalControl_A186
PA188	SignalControl_A187
PA189	SignalControl_A188
PA190	SignalControl_A189
PA191	SignalControl_A190
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PA193	SignalControl_A192
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PA195	SignalControl_A194
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PA197	SignalControl_A196
PA198	SignalControl_A197
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PA200	SignalControl_A199
PA201	SignalControl_A200
PA202	SignalControl_A201
PA203	SignalControl_A202
PA204	SignalControl_A203
PA205	SignalControl_A204
PA206	SignalControl_A205
PA207	SignalControl_A206
PA208	SignalControl_A207
PA209	SignalControl_A208
PA210	SignalControl_A209
PA211	SignalControl_A210
PA212	SignalControl_A211
PA213	SignalControl_A212
PA214	SignalControl_A213
PA215	SignalControl_A214
PA216	SignalControl_A215
PA217	SignalControl_A216
PA218	SignalControl_A217
PA219	SignalControl_A218
PA220	SignalControl_A219
PA221	SignalControl_A220
PA222	SignalControl_A221
PA223	SignalControl_A222
PA224	SignalControl_A223
PA225	SignalControl_A224
PA226	SignalControl_A225
PA227	SignalControl_A226
PA228	SignalControl_A227
PA229	SignalControl_A228
PA230	SignalControl_A229
PA231	SignalControl_A230
PA232	SignalControl_A231
PA233	SignalControl_A232
PA234	SignalControl_A233
PA235	SignalControl_A234
PA236	SignalControl_A235
PA237	SignalControl_A236
PA238	SignalControl_A237
PA239	SignalControl_A238
PA240	SignalControl_A239
PA241	SignalControl_A240
PA242	SignalControl_A241
PA243	SignalControl_A242
PA244	SignalControl_A243
PA245	SignalControl_A244
PA246	SignalControl_A245
PA247	SignalControl_A246
PA248	SignalControl_A247
PA249	SignalControl_A248
PA250	SignalControl_A249

Revision History Table

Rev	Docu	Number
1	C	SM22-7-1287
2	C	SM22-7-1287
3	C	SM22-7-1287
4	C	SM22-7-1287
5	D	SM22-7-1287



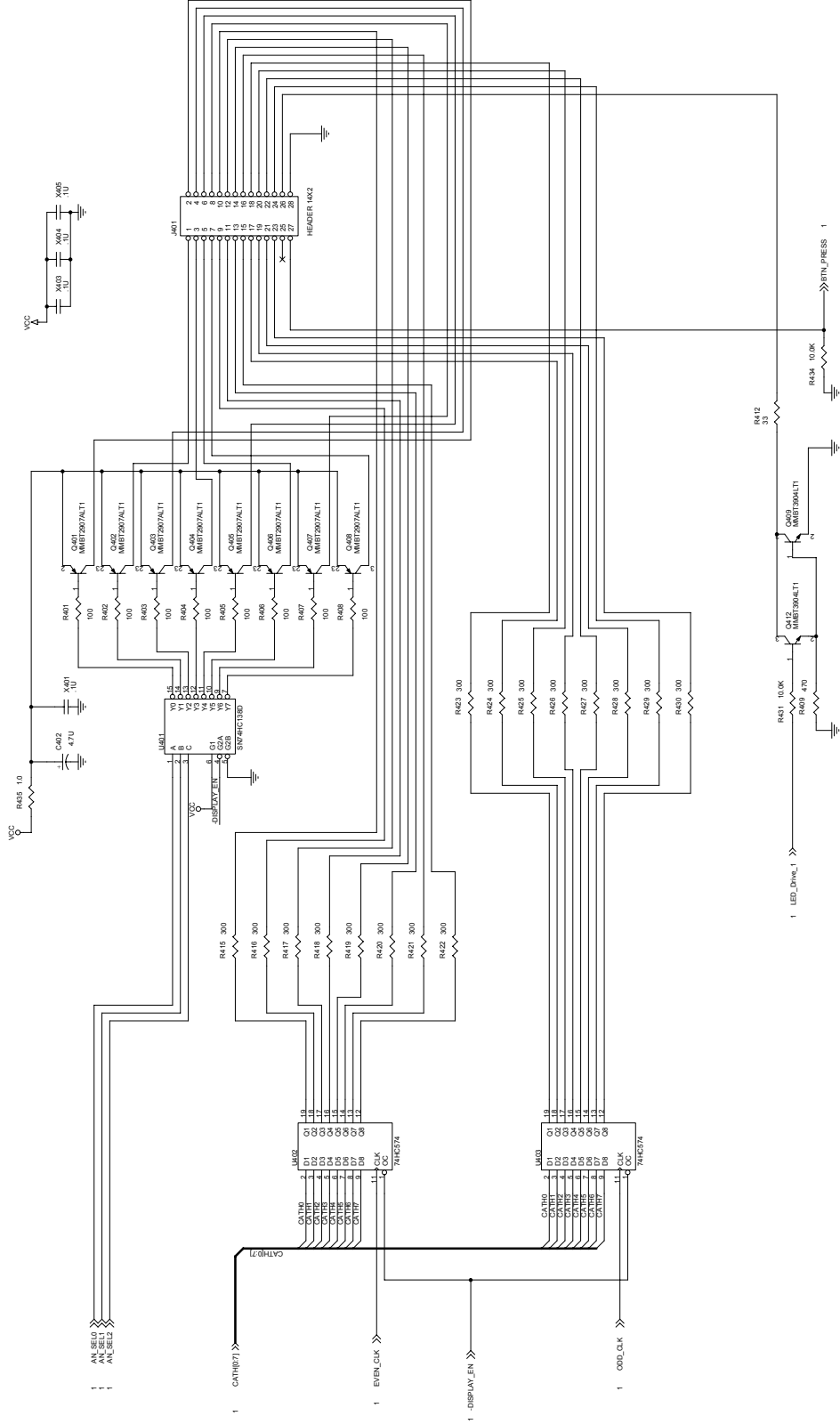
1 Channel\_1\_ONBARCOFF  
 1 Channel\_2\_ONBARCOFF  
 1 Channel\_3\_ONBARCOFF  
 1 Channel\_4\_ONBARCOFF



- 2 Channel\_1\_V+
- 2 Channel\_2\_V+
- 2 Channel\_3\_V+
- 2 Channel\_4\_V+
- 2 Channel\_1\_V-
- 2 Channel\_2\_V-
- 2 Channel\_3\_V-
- 2 Channel\_4\_V-

1 A\_Bn\_D\_SignalChannel\_A0  
1 A\_Bn\_D\_SignalChannel\_A1





Rev	Diode Matrix Display Driver
Doc Number	7-11287
Rev C	
Doc C	
Doc C	
Doc C	

