Operation and Service Manual

Diode Temperature Monitor

SIM922A

Stanford Research Systems

Revision 1.3 • August 24, 2006

Certification

Stanford Research Systems certifies that this product met its published specifications at the time of shipment.

Warranty

This Stanford Research Systems product is warranted against defects in materials and workmanship for a period of one (1) year from the date of shipment.

Service

For warranty service or repair, this product must be returned to a Stanford Research Systems authorized service facility. Contact Stanford Research Systems or an authorized representative before returning this product for repair.

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Contents

General Information

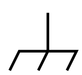
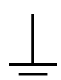
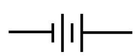
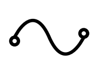
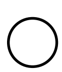
The SIM922A Diode Temperature Monitor, part of Stanford Research Systems' Small Instrumentation Modules family, consists of a single-channel sensor excitation and readout for precision low-noise diode thermometry. Front-panel analog outputs provide both a scaled (linear voltage proportional to temperature) and raw (buffered sensor voltage) signal. The 10 μA DC current source provides sensor excitation to the four-wire measurement circuit.

Service

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

The SIM922A 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	1			
	Sensor type	Silicon, GaAs, or GaAlAs diode			
	Measurement type	4–wire			
	Excitation	constant current			
		9.999	10	10.001	μA DC, ±5 ppm/°C
Sensor Characteristics	Sensor units	Volts			
	Input Range	-7.5		7.5	V
	Calibration curves	1 built-in			
		1 user defined curve			
	Curve size (each)			1024	points
	Temperature range	1.4		475	K (typical)
		sensor dependent			
Measurement	Measurement Rate	5 readings per second			
		10 per second (autocal. off)			
	Display resolution		4		digits
	Interface resolution		7		digits
	Measurement resolution		4		μV rms
	Accuracy, (23 ± 1)°C	20 μV + 0.01 %			
	Temperature coefficient	−5		+5	ppm/°C
Operating	Temperature	0		40	°C
	Power	±15, +5			V DC
	Supply current	50 (±15 V), 250 (+5 V)			mA

General Characteristics

Interface	Serial (RS-232) through SIM interface
Connectors	DB–9 (female)
	4–wire measurement + ground
	DB–15 (male) SIM interface
Weight	1.4 lbs
Dimensions	1.5″ W × 3.6″ H × 7.0″ D

1 Getting Started

This chapter gives you the necessary information to get started quickly with the SIM922A Diode Temperature Monitor.

In This Chapter

1.1 Introduction to the Instrument

The SIM922A Diode Temperature Monitor monitors up a diode thermometer using a precision 10 μA DC current excitation. Analog outputs, both proportional to temperature and the buffered sensor voltage, are available on the front panel.

1.1.1 Overview

The SIM922A has a commandable, precision 10 μA current source, Disabling the excitation switches off the readout.

A precision 24–bit analog-to-digital converter alternates between measuring the sensor voltage and an internal autocalibration cycle. New sensor measurements are available at a rate of 5 conversions per second.

1.2 Front-Panel Operation

The front panel of the SIM922A(see Figure 1.1) provides a simple operator interface.

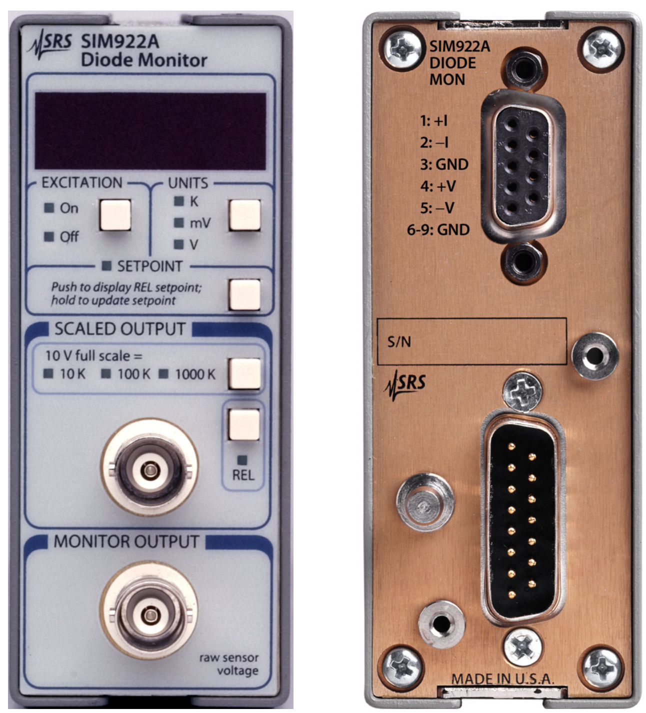


Figure 1.1: The SIM922A front and rear panels.

1.2.1 Excitation

The 10 μA current source of the SIM922A Diode Temperature Monitor can be enabled or disabled from the front panel.

To toggle the excitation, tap the [Excitation]. The excitation can also be controlled with the EXON remote interface command.

1.2.2 Units

The SIM922A displays the results either as raw sensor units (in volts) or temperature (in kelvin). Pressing [Units] toggles between these two modes; the active units are indicated by the illuminated *K*, or *V* (or mV). The display mode can also be controlled with the DISP remote interface command.

When temperature units are selected, a sensor calibration curve is required. The SIM922A is preprogrammed with a standard curve for Si diode sensors. The SIM922A also has non-volatile memory to store a separate sensor curve with up to 1024 temperature-vs-voltage points. The actual curve to use is selected with the remote interface CURV command.

1.2.3 Setpoint

The scaled analog output can produce a voltage proportional to either absolute temperature, or temperature deviation around some setpoint. The [Setpoint] is used to review or set the setpoint temperature. Briefly tapping the [Setpoint] toggles the display between showing the latest reading, and showing the setpoint temperature (indicated by the *SETPOINT* lamp).

Holding [Setpoint] for longer than ~1 second will update the setpoint temperature, as indicated by the word SEt flashing on the display. There are two different behaviors that can occur, depending on the state of the numeric display.

- If the display is presently showing the setpoint (the *SETPOINT* lamp is lit), then long presses of [Setpoint] will toggle between commanding the setpoint temperature to 273.15 K and the most recent measurement result.
- If the display is presently showing the measurement result (the *SETPOINT* lamp is *not* lit), then long presses of [Setpoint] simply update the setpoint to the most recent measurement result.

To configure the SIM922A for an arbitrary setpoint, see the TSET remote interface command.

1.2.4 Scaled Output

The [Scale] controls the gain for the scaled analog output. Gain is indicated by the temperature span corresponding to a full-scale output voltage (10 V). Three scales are available from the front panel, 10 K (1 V/K), 100 K (0.1 V/K), and 1000 K (0.01 V/K). To configure the SIM922A for an arbitrary analog scale, see the VKEL remote interface command.

The [Rel] toggles the scaled output between two modes: absolute ($V \propto T$), and relative ($V \propto T - T_{\text{set}}$). Relative mode can also be controlled with the AMOD remote interface command.

1.3 Sensor Interface

The sensor interface on the SIM922A consists of a rear-panel DB–9/F connector (see Figure 1.1). The connector pinout is given in Table 1.1

Pin	Signal
1	I+
2	I–
3	ground
4	V+
5	V−
6–9	ground

Table 1.1: SIM922A Sensor Interface Connector Pin Assignments, DB–9

1.3.1 Four-wire measurement

To avoid sensitivity to wiring lead resistance, the SIM922A is configured for four-wire measurements. The basic circuit for this wiring scheme is shown in Figure 1.2.

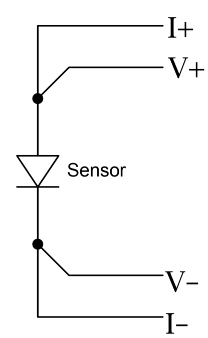


Figure 1.2: Wiring diagram for four-wire readout.

1.3.2 Two-wire measurement

If application-specific constraints limit the number of leads to the sensor, the SIM922A 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.

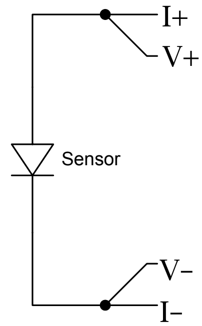


Figure 1.3: Wiring diagram for two-wire readout.

1.4 SIM Interface

The primary connection to the SIM922A Diode Temperature Monitor is the rear-panel DB–15 SIM interface connector. Typically, the SIM922A 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 SIM922A directly, without using the SIM900 Mainframe. This section provides details on the interface.

⚠ CAUTION

The SIM922A 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 SIM922A 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 SIM922A)
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 SIM922A)

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

1.4.2 Direct interfacing

The SIM922A 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, ±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 SIM922A independent of the SIM900 Mainframe, communication is usually possible by directly connecting the appropriate interface lines from the SIM922A DB–15 plug to the RS-232 serial port of a personal computer.[1] Connect RXD from the SIM922A 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 SIM922A, 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 SIM922A		Name
	DB–9/F	
3 ⟷	7	RTS
4 ⟷	8	CTS
10 ⟷	3	TxD
11 ⟷	2	RxD
	5	Computer Ground
	to P/S	
7 ⟷	−15 VDC	
14 ⟷	+15 VDC	
13 ⟷	+5 VDC	
8,9 ⟷	Ground (P/S return current)	
1 ⟷	Signal Ground (separate wire to Ground)	

Table 1.3: SIM922A Direct Interface Cable Pin Assignments

[1] 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 SIM922A supports is 38400. The minimum baud rate is 110. Above 38400, the SIM922A 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 SIM922A and the SIM900 Mainframe.

2 Remote Operation

This chapter describes operating the SIM922A over the serial interface.

In This Chapter

2.1 Index of Common Commands

symbol	definition
i,j	Integers
f,g	Floating-point values
z	Literal token
s	Arbitrary character sequence (no "," or ";")
(?)	Required for queries; illegal for set commands
var	Parameter always required
{*var*}	Required parameter for set commands; illegal for queries
[*var*]	Optional parameter for both set and query forms

2.2 Alphabetic List of Commands

★

A

B

C

D

E

F

L

2.3 Introduction

Remote operation of the SIM922A 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 SIM922A 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 SIM922A are buffered in a 32-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 SIM922A 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 SIM922A is left unchanged; to reset the instrument, see *RST.

The Device Clear signal will also terminate any streaming outputs from the SIM922A due to a TVAL?, TDEV?, or VOLT? 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,j	Integers
f,g	Floating-point values
z	Literal token
s	Arbitrary character sequence (no “,” or “;”)
(*?*)	Required for queries; illegal for set commands
var	Parameter always required
{*var*}	Required parameter for set commands; illegal for queries
[*var*]	Optional parameter for both set and query forms

2.4.3 Readout commands

VOLT? [*n*]

Voltage Value

Query the sensor voltage.

The result is formatted as `+#.######E+##`, where + indicates sign ("+" or "−"), and the value following `E` is a power-of-ten that multiplies the preceeding value.

If the optional parameter *n* is provided, then *n* sequential conversion results are returned to the host. If *n*=0, the conversion results continue indefinitely. To terminate the stream before *n* results (or when *n*=0), issue the SOUT command.

Note that omitting *n* is equivalent to *n*=1.

TVAL? [*n*]

Temperature Value

Query the sensor temperature value.

The result is formatted identically to VOLT, above.

If the optional parameter *n* is provided, then *n* sequential conversion results are returned to the host. If *n*=0, the conversion results continue indefinitely. To terminate the stream before *n* results (or when *n*=0), issue the SOUT command.

Note that omitting *n* is equivalent to *n*=1.

TDEV? [*n*]

Temperature Deviation Value

Query the sensor temperature minus setpoint value.

The result is formatted identically to VOLT, above.

If the optional parameter *n* is provided, then *n* sequential conversion results are returned to the host. If *n*=0, the conversion results continue indefinitely. To terminate the stream before *n* results (or when *n*=0), issue the SOUT command.

Note that omitting *n* is equivalent to *n*=1.

SOUT

Stop Streaming

Turn off streaming output.

CHOP(?) {*z*}

Autocalibration On/Off

Set (query) the internal autocalibration mode {to *z*=(OFF 0, **ON 1**)}.

When CHOP ON, the SIM922A alternates successive ADC conversions between sensor measurements, and internal calibration measurements for scale and offset. The resulting sensor measurements are then available at a rate of 5 per second.

When CHOP OFF, the SIM922A uses the most recently determined scale and offset without further internal calibration, and all ADC conversions are of the sensor. The resulting sensor measurements are then available at a rate of 10 per second.

For special applications requiring high readout rate, it may be of interest to periodically (every few minutes) briefly cycle CHOP ON, then return to CHOP OFF, and then record the updated scale and offset calibrations with VSCA? and COFF?. This can allow an off-line recalibration of sensor voltage readings accounting for slow internal drifts of the scale and offset analog components.

COFF?

Internal Offset

Query the internal offset value, in units of ADC counts.

VSCA?

Internal Scale

Query the internal scale value, in units of volts per ADC count.

2.4.4 Setpoint and analog output commands

TSET(?) {*f*}

Temperature Setpoint

Set (query) the temperature setpoint {to *f* kelvin}. This is the "offset" value used for the scaled analog output when in AMOD REL mode.

VKEL(?) {*f*}

Temperature Scale Factor

Set (query) the temperature scale factor {to *f*}, in volts per kelvin. When set to 1.0, 0.1, or 0.01, the corresponding front panel scale indicator (10 V = 10 K, 100 K, or 1000 K) is lit; when set to any other value, all three indicators are dark.

AMOD(?) {*z*}	Analog Output Mode Set (query) the analog output mode {to *z*=(**ABS 0**, REL 1, MAN 2)}. In AMOD ABS, the scaled output is given by $$V = T \times \text{VKEL}.$$ In AMOD REL, the output is given by $$V = (T - T_{\text{set}}) \times \text{VKEL}.$$ In AMOD MAN, the output is controlled by AOUT.
AOUT(?) {*f*}	Analog Output Voltage Set (query) the manual analog output {to *f*}, in volts.

2.4.5 Excitation commands

EXON(?) {*z*}	Excitation On/Off Set (query) the 10 μA excitation current {to *z*=(OFF 0, **ON 1**)}.

2.4.6 Display & configuration commands

DISX(?) {*z*}	Display Enable/Disable Set (query) the front panel display {to *z*=(OFF 0, **ON 1**)}. The DISX setting is *not* stored in non-volatile memory. At power-on, the SIM922A returns to DISX ON.
DISP(?) {*z*}	Display Mode Set (query) the display mode {to *z*=(VOLT 0, **TEMP 1**, or TSET 2)}. If DISP VOLT, then results are displayed in volts or millivolts; if DISP TEMP, results are displayed in kelvin. If DISP TSET, the display shows the setpoint temperature.
FPLC(?) {*i*}	Frequency of Power Line Cycle Set (query) the power line rejection frequency {to *j*=(50, 60)}, in Hz.

2.4.7 Sensor calibration commands

In addition to the built-in curve, the SIM922A has a dedicated 1024-point non-volatile memory for storing user calibration data. Once loaded, this curve is retained by the SIM922A though power cycles.

CINI(?) {*z*,*s*}

Initialize Sensor Calibration

Initialize sensor calibration curve.

The set form of the command, CINI *z*,*s*, erases the old curve. The parameter *z*specifies the curve format, as one of:

z	meaning
`LINEAR 0`	volts, kelvin
`SEMILOGT 1`	volts, $\log_{10}$(kelvin)
`SEMILOGV 2`	$\log_{10}$(volts), kelvin
`LOGLOG 3`	$\log_{10}$(volts), $\log_{10}$(kelvin)

The second 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.

If CURV `USER` was active when CINI is executed, the SIM922A reverts to CURV `STAN`, and records an execution error (EXE bit in the ESR) of "uninitialized curve."

The query form of the command, CINI?, 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 *f*,*g*

Add User Curve Point

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

Note that curve points *must* be added in increasing order of sensor value *f*. Legal temperature values must be in the range $1\,\mathrm{mK} \leq T \leq 9999.499\,\mathrm{K}$.

CAPT? *j*

Query User Curve Point

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

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

CURV(?) {*z*}

Select Sensor Curve

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

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.

2.4.8 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 SIM922A, 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 SIM922A 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 SIM922A defaults to PARI `NONE`.

2.4.9 Status commands

The Status commands query and configure registers associated with status reporting of the SIM922A. 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*].

Execution of the *STB? query (without the optional bit *i*) always causes the −STATUS signal to be deasserted. Note that *STB? *i* will *not* clear −STATUS, even if bit *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*] {to *j*}.

*ESR? [*i*]

Standard Event Status

Reads the Standard Event Status Register [bit *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*] {to *j*}.

CESR? [*i*]

Communication Error Status

Query Communication Error Status Register [for bit *i*].

Upon executing a CESR? query, the returned bit(s) of the CESR register are cleared.

CESE(?) [*i*,]{*j*}

Communication Error Status Enable

Set (query) Communication Error Status Enable Register [bit *i*] {to *j*}.

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

2.4.10 Interface commands

*RST	Reset Reset the SIM922A to default configuration. The following commands are internally executed upon *RST: • DISX ON • EXON ON • CURV STAN • DISP TEMP • AMOD ABS • VKEL 1 • CHOP ON

CONS(?) {*z*}

Console Mode

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

CONS causes each character received at the Input Buffer to be copied to the Output Queue.

At power-on and Device-Clear, CONS is set to OFF.

***IDN?**

Identify

Read the device identification string.

The identification string is formatted as:
`Stanford_Research_Systems,SIM922A,s/n******,ver#.##`
where `******` is the 6-digit serial number, and `#.##` is the firmware revision level.

***OPC(?)**

Operation Complete

Operation Complete. Sets the OPC flag in the ESR register.

The query form *OPC? writes a 1 in the output queue when complete, but does not affect the ESR register.

LEXE?

Execution Error

Query the last execution error code. Valid codes are:

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	Illegal temperature value
20	No Excitation

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

LBTN?

Button

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

Value	Definition
0	no button pressed since last query
1	[Scale]
2	[Setpoint]
3	[Units]
4	[Excitation]
5	[Rel]

TOKN(?) {z}

Token Mode

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

If TOKN ON is set, then queries to the SIM922A that return tokens will return the text keyword; otherwise they return the decimal integer value.

Thus, the only possible responses to the TOKN? 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 SIM922A 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 three categories of registers in the SIM922A status model:

Condition Registers : These read-only registers correspond to the real-time condition of some underlying physical property being monitored. Queries return the latest value of the property, and have no other effect. Condition register names end with CR.

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.

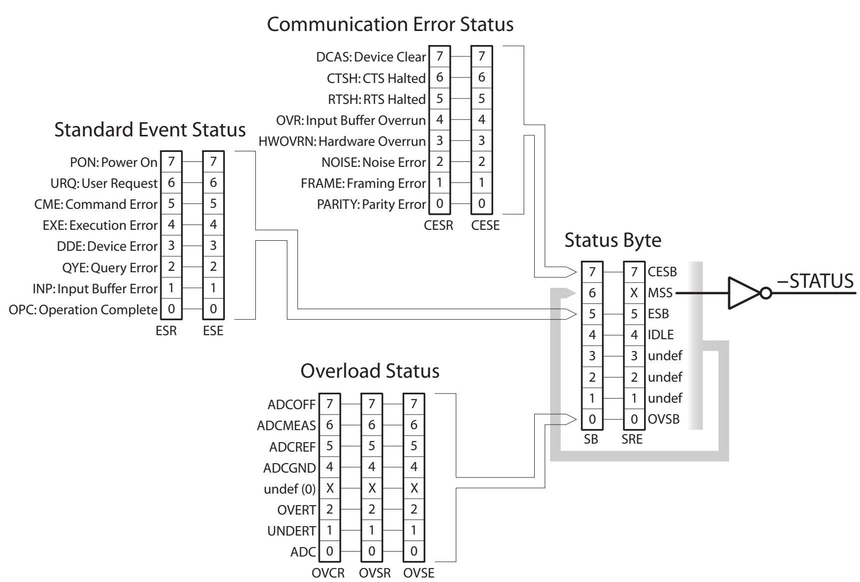


Figure 2.1: Status Register Model for the SIM922A Diode Temperature Monitor.

2.5.1 Status Byte (SB)

The Status Byte is the top-level summary of the SIM922A status model. When masked by the Service Request Enable register, a bit set in the Status Byte causes the −STATUS signal to be asserted on the rear-panel SIM interface connector.

Typically, −STATUS remains asserted (low) until a *STB? query is received, at which time −STATUS is deasserted (raised)[1]. After clearing the −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 SIM922A 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 −STATUS is released by the *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 *STB? query. These bits are only cleared by reading the underlying event registers, or by clearing the corresponding enable registers.

[1] 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 −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. Not used in the SIM922A.

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 SIM922A. Command Error. Indicates a parser-detected error.

CTSH : Undefined for the SIM922A.

DCAS : Device Clear. Indicates the SIM922A 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 (OVCR)

The Overload Condition Register consists of 7 single-bit monitors of condition events within the SIM922A. Bits in the OVCR reflect the real-time values of their corresponding signals. Reading the entire register, or individual bits within it, does not affect the OVCR.

Weight	Bit	Flag
1	0	ADC
2	1	UNDERT
4	2	OVERT
8	3	undef (0)
16	4	ADCGND
32	5	ADCREF
64	6	ADCMEAS
128	7	ADCOFF (0)

ADC : Analog-to-Digital overload. The digitizer input was overloaded ($-7.5\,\mathrm{V} \le V_{\mathrm{in}} \le +7.5\,\mathrm{V}$).

UNDERT : Calibration curve underflow ($V < V_{\mathrm{min}}$).

OVERT : Calibration curve overflow ($V > V_{\mathrm{max}}$).

ADCGND : Flags an ADC overload on the internal offset calibration (with CHOP ON).

ADCREF : Flags an ADC overload on the internal scale calibration (with CHOP ON).

ADCMEAS : Flags an ADC overload on the external sensor measurement.

ADCOFF : Flags an ADC overload on the external sensor while the excitation current is off (EXON OFF).

2.5.8 Overload Status (OVSR)

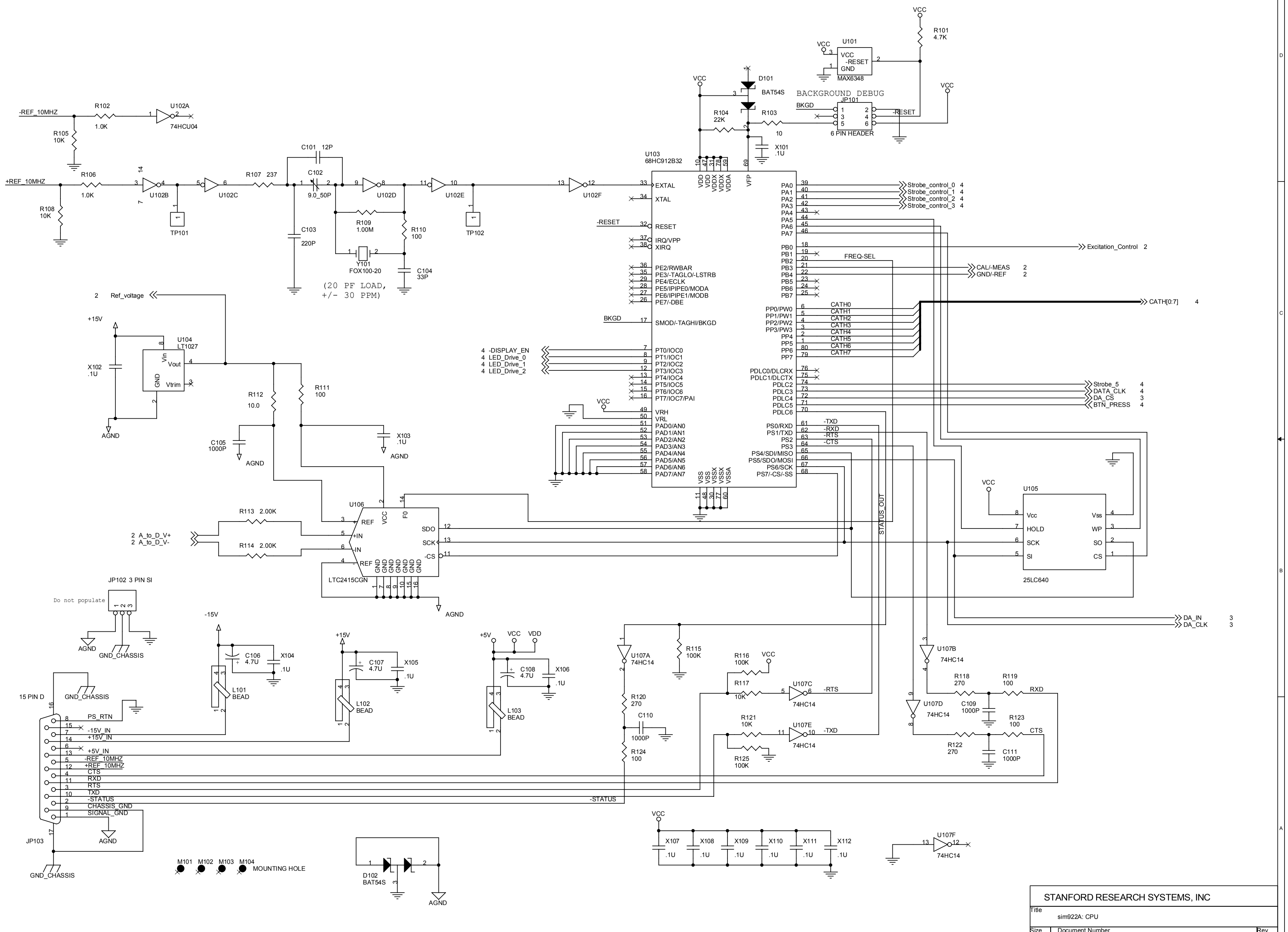
The Overload Status Register consists of (latching) event flags that correspond one-to-one with the bits of the OVCR (see above). Upon the transition $0 \to 1$ of any bit within the OVCR, the corresponding bit in the OVSR becomes set.

Bits in the OVSR are unaffected by the $1 \to 0$ transitions in the OVCR, and are cleared only by reading or with the *CLS command. Reading a single bit (with the OVSR? *i* query) clears only bit *i*.

2.5.9 Overload 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.



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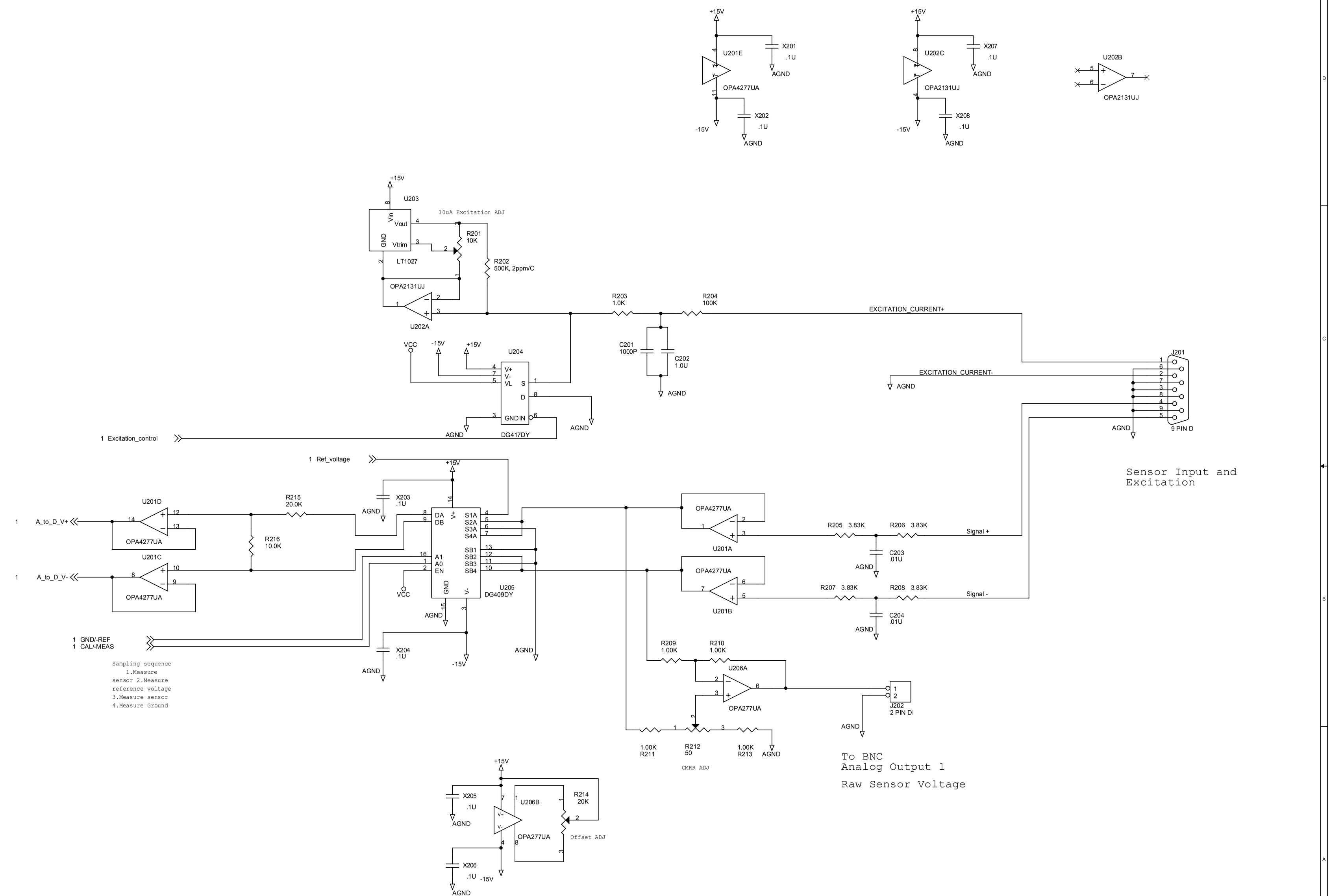

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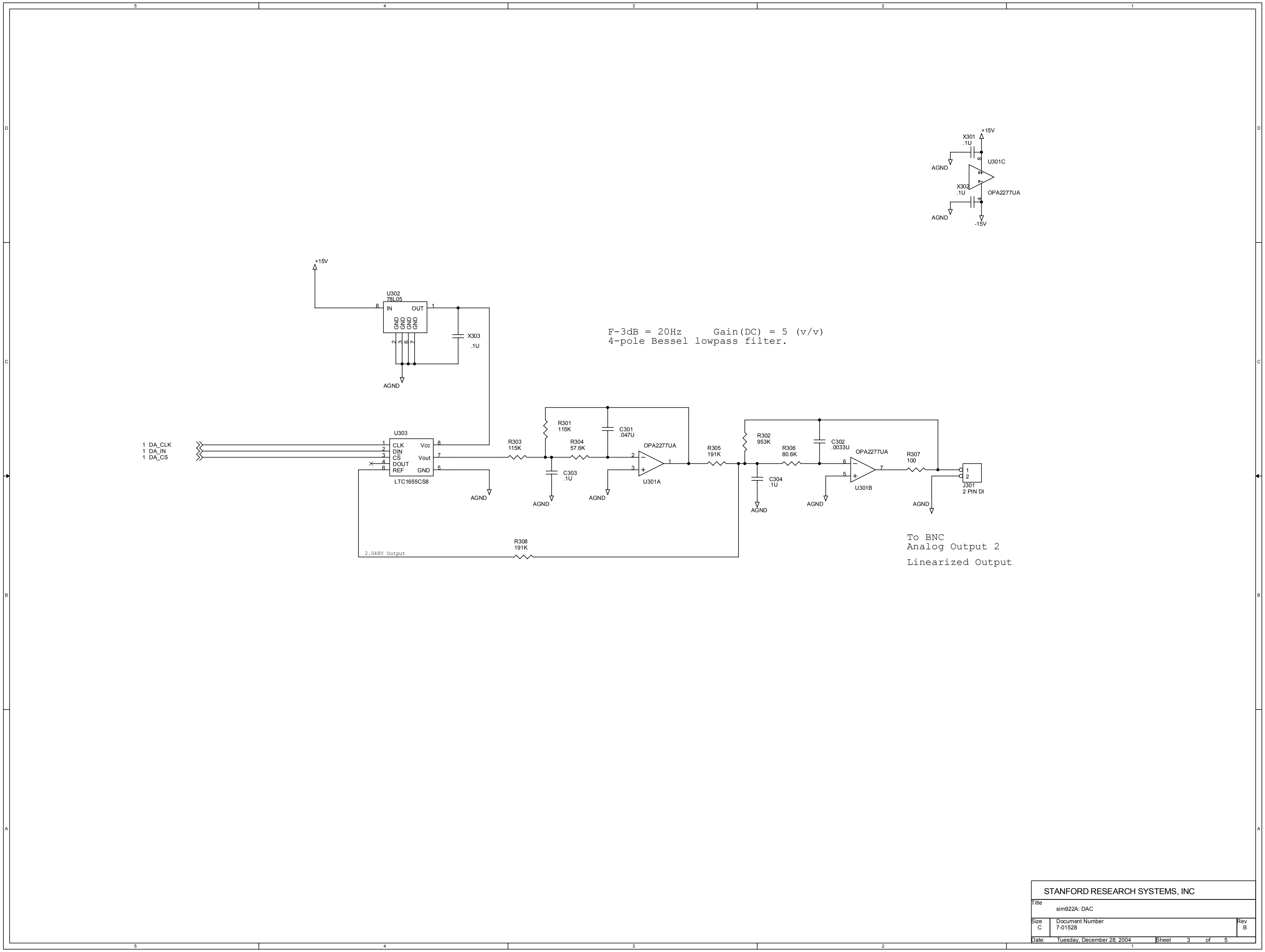

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78L05
IN
OUT
GND
X303
.1U
+15V
AGND
U303
CLK
DIN
CS
DOUT
REF
Vcc
Vout
GND
LTC1655CS8
1 DA_CLK
1 DA_IN
1 DA_CS
R303
115K
R301
115K
R304
57.6K
C301
.047U
C303
.1U
OPA2277UA
U301A
R305
191K
R302
953K
R306
80.6K
C302
.0033U
C304
.1U
U301B
R307
100
J301
2 PIN DI
R308
191K
2.048V Output
X301
.1U
X302
.1U
U301C
-15V
F-3dB = 20Hz Gain(DC) = 5 (v/v)
4-pole Bessel lowpass filter.
To BNC
Analog Output 2
Linearized Output
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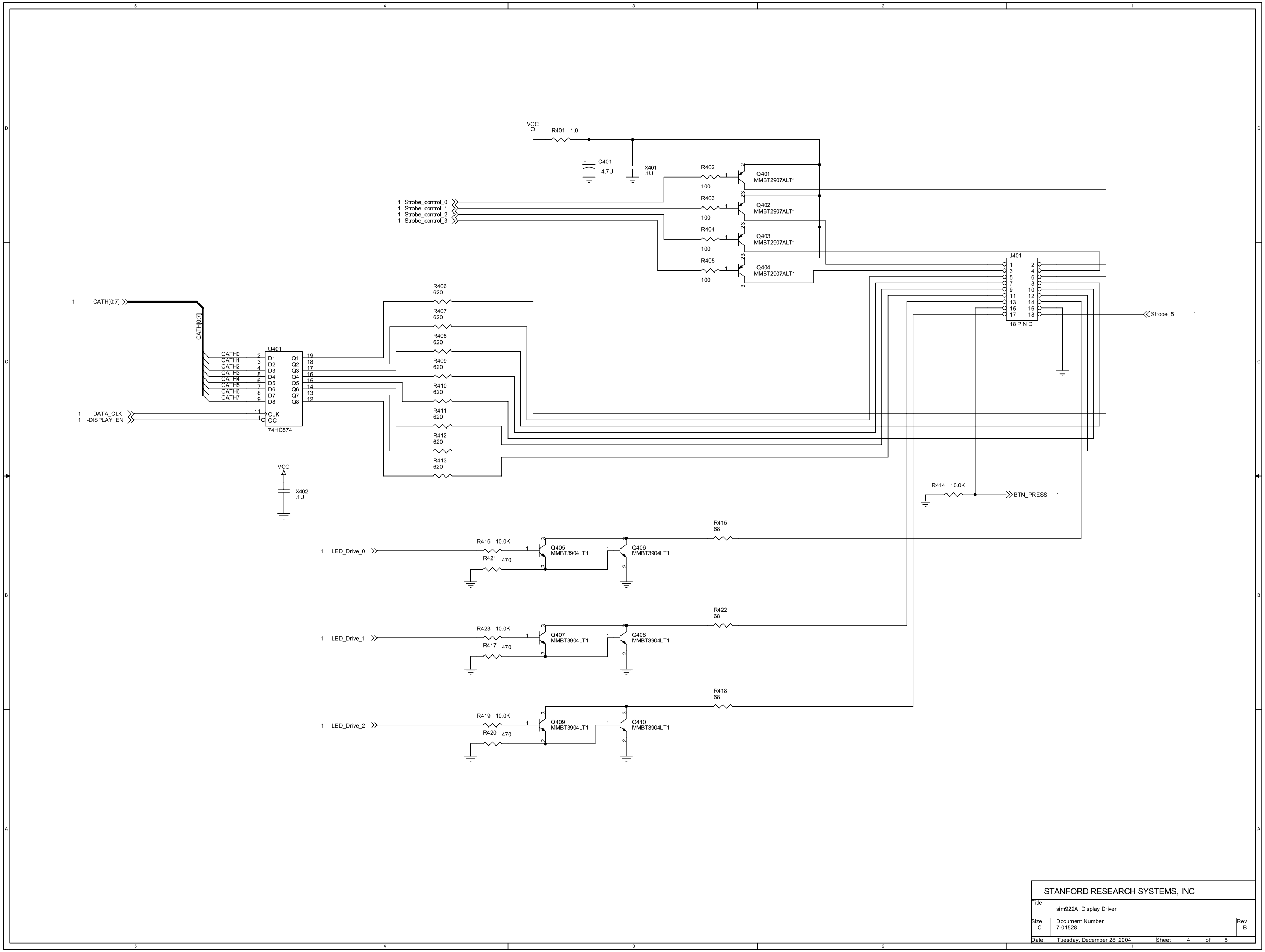
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C401 4.7U
X401 .1U
R402 100
R403 100
R404 100
R405 100
Q401 MMBT2907ALT1
Q402 MMBT2907ALT1
Q403 MMBT2907ALT1
Q404 MMBT2907ALT1
1 Strobe_control_0
1 Strobe_control_1
1 Strobe_control_2
1 Strobe_control_3
J401
18 PIN DI
Strobe_5 1
1 CATH[0:7]
CATH[0:7]
CATH0
CATH1
CATH2
CATH3
CATH4
CATH5
CATH6
CATH7
U401
74HC574
1 DATA_CLK
1 -DISPLAY_EN
R406 620
R407 620
R408 620
R409 620
R410 620
R411 620
R412 620
R413 620
VCC
X402 .1U
R414 10.0K
BTN_PRESS 1
1 LED_Drive_0
R416 10.0K
R421 470
Q405 MMBT3904LT1
Q406 MMBT3904LT1
R415 68
1 LED_Drive_1
R423 10.0K
R417 470
Q407 MMBT3904LT1
Q408 MMBT3904LT1
R422 68
1 LED_Drive_2
R419 10.0K
R420 470
Q409 MMBT3904LT1
Q410 MMBT3904LT1
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Rev B
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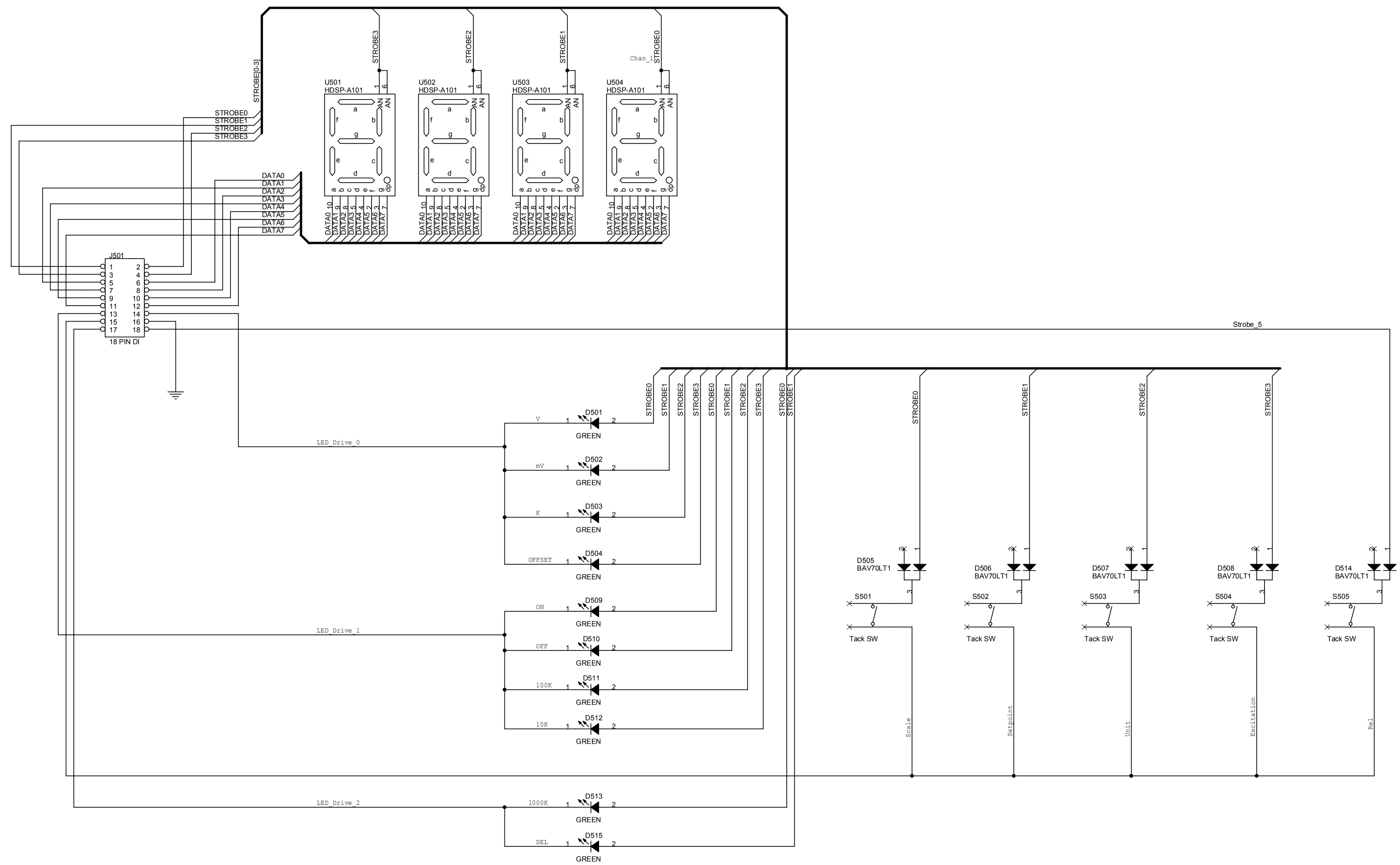

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