T R I M B L E N A V I G A T I O N

SVeeSix™
System Designer's Reference Manual

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Sunnyvale, CA 94088-3642

Part Number 25856-00 Rev. A

NMEA 0183

NMEA 0183 is a well-established, industry standard ASCII protocol created by the National Marine Electronics Association. Although originally established for marine electronic equipment, NMEA 0183 has also gained popularity in other applications as well.

The standard NMEA firmware for the SVeeSix is configured to output two common messages: GGA and VTG. For a nominal fee, Trimble Navigation can offer custom firmware with a different selection of messages to meet your application requirements. The basic NMEA 0183 message structure is shown below.

$IDMSG,D1,D2,D3,D4,. . . . . .,Dn*CS[CR][LF]

$IDMSG	The message header identifying the source of the data and the message structure.
,D1...,Dn	Each message contains multiple data fields (Dn) which are delimited by commas.
*CS	The checksum field, delimited by an asterisk (*), is optional for most NMEA 0183 messages.
[CR][LF]	The carriage return [CR] and line feed [LF] combination terminates the message.

NMEA Software

The Developer's Starter Kit does not include a monitor program for NMEA 0183, but the Terminal mode in GPSSK may be used to view the NMEA output. Refer to the help feature in GPSSK for information on the Terminal mode. Also, any standard serial communication program can be used. The NMEA 0183 protocol and message structure is described in detail in Appendix E.

Time Output

Serial Output

The SVeeSix is an excellent source of accurate time for precise time standards, data acquisition systems, communication networks and data networks. The TSIP, TAIP and NMEA protocols include time messages. Refer to Report Packet 41 in Appendix A, the TM message in Appendix C or the ZDA message in Appendix E for a description of the time reports for each protocol.

Note that GPS time differs from UTC (Universal Coordinated Time) by a variable, integer number of seconds, as described below.

$$UTC = (GPS\ time) - (GPS/UTC\ offset)$$

As of June 1994, the GPS/UTC offset was 10 seconds. The offset increases by 1 second approximately every 18 months. System designers should plan to read the offset value as a part of the timing interface to obtain UTC. The GPS week number is in reference to a base week (Week #0), starting January 6, 1980. See Chapter 6 for further information on timing output.

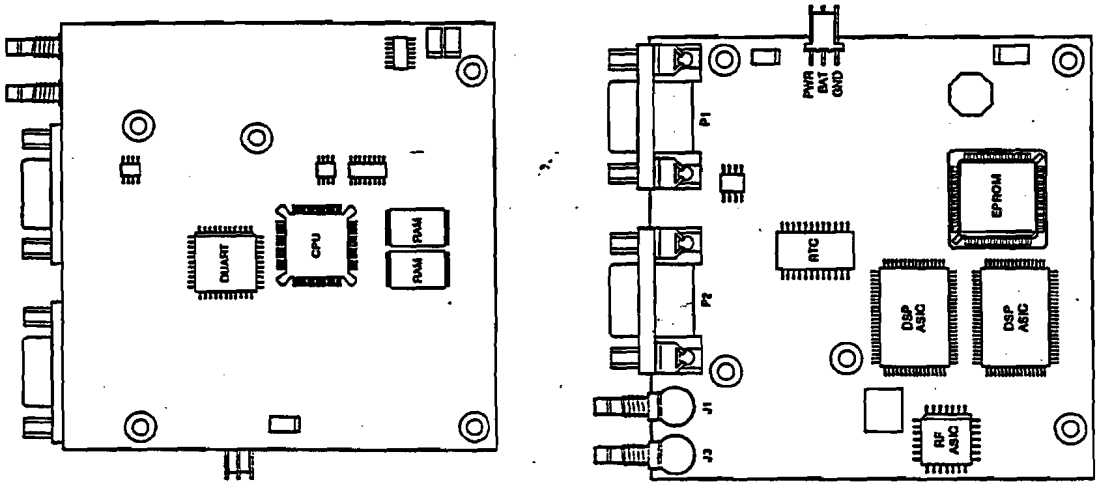
The SVeeSix Timing Module

The SVeeSix Timing module is designed for integration with precise time/frequency standards. It is a special configuration of the SVeeSix with the following features:

- ❒ Dual RS-422 Serial Ports
- ❒ DGPS Capability
- ❒ Open Collector One PPS Output
- ❒ 5-Volt Input Power (see specification below)
- ❒ No Onboard Oscillator, Requires External 16 f_O Input (see specification below)
- ❒ TSIP Timing Code (see description below)

The SVeeSix timing module is illustrated below.

Figure 6-1
The SVeeSix Timing Module



5-Volt Input Power

Since the SVeeSix timing module is normally used embedded applications, it is designed for a regulated 5-volt DC power supply with a tolerance of -3% (4.85 VDC) to +5% (5.25 VDC). The maximum allowable ripple in the 5-volt supply is shown in the chart on page 6-21.

Appendix E
NMEA 0183

NMEA 0183 is an interface protocol created by the National Marine Electronics Association. The latest release of NMEA 0183 is Version 2.00. This protocol was originally established to allow marine navigation equipment to share information. NMEA 0183 is a simple, yet comprehensive ASCII protocol which defines both the communication interface and the data format. Since it is a well established industry standard, NMEA 0183 has also gained popularity for use in applications other than marine electronics.

For those applications requiring output only from the GPS receiver, NMEA 0183 is a popular choice since, in many cases, an NMEA 0183 software application code already exists. The SVeeSix receiver is available with firmware that supports a subset of the NMEA 0183 messages: GGA and VTG. For a nominal fee, Trimble can offer custom firmware with a different selection of messages to meet your application requirements.

This appendix provides a brief overview of the NMEA protocol and describes both the standard and optional messages offered by the SVeeSix.

For a complete copy of the NMEA 0183 standard, contact:

National Marine Electronics Association
Executive Director
PO Box 50040
Mobile, Alabama 36605

- NOTE: ***NMEA data is output on port 1 of the SVeeSix receiver. Differential-ready SVeeSix receivers are configured to receive RTCM SC-104 formatted corrections on port 1. Applications using both NMEA and differential GPS may require the user to supply a split cable to separate the NMEA output and the RTCM input on port 1.***

The NMEA 0183 Communication Interface

NMEA 0183 allows a single source (talker) to transmit serial data over a single twisted wire pair to one or more receivers (listeners). The table below lists the characteristics of the NMEA 0183 data transmissions.

Table E-1
NMEA 0183 Characteristics

Signal Characteristic	NMEA Standard
Baud Rate	4800
Data Bits	8 (d7=0)
Parity	None (Disabled)
Stop Bits	1

NMEA 0183 Message Format

The NMEA 0183 protocol covers a broad array of navigation data. This broad array of information is separated into discrete messages which convey a specific set of information. The entire protocol encompasses over 50 messages, but only a sub-set of these messages apply to a GPS sensor like the SVeeSix. The NMEA message structure is described below.

$IDMSG,D1,D2,D3,D4,. . . . . .,Dn*CS[CR][LF]

"$"	The "$" signifies the start of a message
ID	The talker identification is a two letter mnemonic which describes the source of the navigation information. The GP identification signifies a GPS source.
MSG	The message identification is a three letter mnemonic which describes the message content and the number and order of the data fields.
","	Commas serve as delimiters for the data fields.
Dn	Each message contains multiple data fields (Dn) which are delimited by commas.
"*"	The asterisk serves as a checksum delimiter. Checksums and checksum delimiters are optional for most NMEA 0183 messages.
CS	The checksum field is optional for most NMEA 0183 messages. It is a two ASCII characters which indicate the hexadecimal value of the checksum.
[CR][LF]	The carriage return [CR] and line feed [LF] combination terminate the message.

NMEA 0183 messages vary in length, but each message is limited to 79 characters or less. This length limitation excludes the "$" and the [CR][LF]. The data field block, including delimiters, is limited to 74 characters or less.

NMEA 0183 Message Options

The standard NMEA 0183 version of the SVeeSix outputs two messages: GGA (NMEA Version 2) and VTG. These messages are output at a 1 second interval with the "GP" talker ID and without checksums.

For a nominal fee, Trimble can offer a custom mix of the messages listed in table E-2. In addition, the talker ID, output interval, and checksum selections can be modified to fit your application requirements. To investigate custom NMEA 0183 firmware, contact your Trimble Navigation representative.

Table E-2
SVeeSix NMEA Messages

Standard	Message	Description
✓	GGA	GPS Fix Data (NMEA Version 2)
	GGA	GPS Fix Data (NMEA Version 1)
	GLL	Geographic Position - Latitude/Longitude
	GSA	GPS DOP and Active Satellites
	GSV	GPS Satellites in View
	RMC	Recommended Minimum Specific GPS/Transit Data
✓	VTG	Track Made Good and Ground Speed
	ZDA	Time & Date

The format for each message in table E-2 is described in more detail in the next section.

NMEA 0183 Message Formats

GGA - GPS Fix Data

The GGA message includes time, position and fix related data for the GPS receiver.

GGA,hhmmss,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx

Field #	Description
1	UTC of Position.
2,3	Latitude, N (North) or S (South).
4,5	Longitude, E (East) or W (West).
6	GPS Quality Indicator: 0 = No GPS, 1 = GPS, 2 = DGPS.
7	Number of Satellites in Use.
8	Horizontal Dilution of Precision (HDOP).
9, 10	Antenna Altitude in Meters, M = Meters.
11,12	Geoidal Separation in Meters, M=Meters. Geoidal separation is the difference between the WGS-84 earth ellipsoid and mean-sea-level.
13	Age of Differential GPS Data. Time in seconds since the last Type 1 or 9 Update.
14	Differential Reference Station ID (0000 to 1023).

GLL - Geographic Position - Latitude/Longitude

The GLL message contains the latitude and longitude of the present vessel position, the time of the position fix and the status.

GLL,llll.ll,a,yyyyy.yy,a,hhmmss,A

Field #	Description
1	UTC of Position.
1,2	Latitude, N (North) or S (South).
3,4	Longitude, E (East) or W (West).
5	UTC of Position.
6	Status: A = Valid, V= Invalid.

NMEA 0183 Message Formats (continued)

GSA - GPS DOP and Active Satellites

The GSA messages indicates the GPS receiver's operating mode and lists the satellites used for navigation and the DOP values of the position solution.

GSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x

Field #	Description
1	Mode: M = Manual, A = Automatic. In manual mode, the receiver is forced to operate in either 2D or 3D mode. In automatic mode, the receiver is allowed to switch between 2D and 3D modes subject to the PDOP and satellite masks.
2	Current Mode: 1 = Fix Not Available, 2 = 2D, 3 = 3D.
3 to 14	PRN numbers of the satellites used in the position solution. When less than 12 satellites are used, the unused fields are null.
15	Position Dilution of Precision (PDOP).
16	Horizontal Dilution of Precision (HDOP).
17	Vertical Dilution of Precision (VDOP).

NMEA 0183 Message Formats (continued)

GSV - GPS Satellites in View

The GSV message identifies the GPS satellites in view, including their PRN number, elevation, azimuth and SNR value. Each message contains data for four satellites. Second and third messages are sent when more than 4 satellites are in view. Fields #1 and #2 indicate the total number of messages being sent and the number of each message respectively.

GSV,x,x,xx,xx,xx,xxx,xx,xx,xx,xxx,xx,xx,xx,xxx,xx,xx,xx,xxx,xx

Field #	Description
1	Total Number of GSV Messages.
2	Message Number: 1 to 3.
3	Total Number of Satellites in View.
4	Satellite PRN Number.
5	Satellite Elevation in Degrees (90° Maximum).
6	Satellite Azimuth in Degrees True (000 to 359).
7	Satellite SNR (Null When Not Tracking).
8,9,10,11	PRN, Elevation, Azimuth and SNR for Second Satellite.
12,13,14,15	PRN, Elevation, Azimuth and SNR for Third Satellite.
16,17,18,19	PRN, Elevation, Azimuth and SNR for Fourth Satellite.

NMEA 0183 Message Formats (continued)

RMC - Recommended Minimum Specific GPS/Transit Data

The RMC message contains the time, date, position, course and speed data provided by the GPS navigation receiver. A checksum is mandatory for this message and the transmission interval may not exceed 2 seconds. All data fields must be provided unless the data is temporarily unavailable. Null fields may be used when data is temporarily unavailable.

RMC,hhmmss,A,llll.ll,a,yyyyy.yy,a,x.x,x.x,xxxxxx,x.x,a*hh

Field #	Description
1	UTC of Position Fix.
2	Status: A = Valid, V = Navigation Receiver Warning
3,4	Latitude, N (North) or S (South).
5,6	Longitude, E (East) or W (West).
7	Speed Over the Ground (SOG) in Knots
8	Track made Good in Degrees True.
9	Date: dd/mm/yy
10,11	Magnetic Variation in Degrees, E = East / W= West
12	Checksum (Mandatory for RMC)

VTG - Track Made Good and Ground Speed

The VTG message conveys the actual track made good (COG) and the speed relative to the ground (SOG).

VTG,x,T,x,M,x.x,N,x,K

Field #	Description
1	Track made Good in Degrees True.
2	Track made Good in Degrees Magnetic.
3,4	Speed Over the Ground (SOG) in Knots.
5,6	Speed Over the Ground (SOG) in Kilometer per Hour.

NMEA 0183 Message Formats (continued)

ZDA - Time & Date

The ZDA message contains UTC, the day, the month, the year and the local time zone.

ZDA,hhmmss,xx,xx,xxxx,xx,xx

Field #	Description
1	UTC
2	Day (01 to 31)
3	Month (01 to 12)
4	Year
5	Local Zone Description Hours (±13 hours). Local zone description is the number of whole hours added to local time to obtain UTC. The zone description is always negative for eastern longitudes.
6	Local Zone Description Minutes. Local zone description minutes using the same sign convention as local zone hours.

◆ NOTE: ***Fields #5 and #6 are null fields in the SVeeSix output. A GPS receiver cannot independently identify the local time zone offsets.***

The GPS Receiver

General	L1 frequency (1575.42 MHz), C/A code (Standard Positioning Service), 6-channel, continuous tracking, differential ready (optional)
Position Accuracy	DGPS = 2 to 5 meters (2 Sigma) steady state conditions with differential Standard = 15 meters (SEP) steady state conditions without selective availability
Velocity Accuracy	0.1 m/sec. (1 Sigma) without selective availability
Time Accuracy	1 microsecond with 1 pulse-per-second output synchronized to UTC
Datum	WGS-84 (220 options and one custom slot)
Acquisition Rate	Momentary signal interruption: 2 seconds typical Momentary power interruption: SV6 less than 30 seconds with RAM battery backup, Cold start: 2 - 5 minutes
Dynamics	Velocity: 500 m/sec. (maximum) Acceleration: 4g (39.2 m/sec.^{2}) Jerk: 20 m/sec.^{3}

Appendix F
Specifications

Environmental Characteristics

Temperature	**Receiver board** Standard Operating, -10°C to + 60°C Extended (option), -40°C to + 85°C Storage, -55°C to +100°C **GPS Antenna** Operating, -40°C to +85°C
Vibration	$0.008g^2/Hz$ 5Hz–20 Hz $0.05g^2/Hz$ 20Hz–100Hz -3dB/octave 100Hz–900Hz *These specifications comply with SAE J1211 requirements*
Altitude	-400 to +18,000 meters MSL
Humidity	95% R.H. condensing @ +60°C

Physical Characteristics

Size and Weight

Module	127 mm x 102 mm x 28 mm (4.97" W x 4.03" D x 0.062" H)	260 g (0.57 lbs.) including mounting flange
Module Flange	173 mm x 102 mm x 2 mm (6.81" W x 4.03" D x 0.062" H)	See above
Board	103 mm x 92 mm x 20 mm (4.06" W x 3.6" D x o.8" H)	80 g (0.18 lbs) with twin DB-9 connectors
GPS Antenna	60 mm (2.35") dia x 19.3 mm (.760") Overall external dimensions dependent of form and mechanical mounting of randome assembly.	60 g (0.13 lbs.)

Power

Micro Conxall connector, 3-pin male socket plug

RAM Backup: optional +3.5 to +14 volts DC input via power cable

Input/Output

Interface

On-board serial port interface through 9-pin connector. Serial port operates at RS-232 or RS-422 levels

Protocols Available

TSIP: Trimble Standard Interface Protocol
TAIP: Trimble ASCII Interface Protocol
NMEA 0183

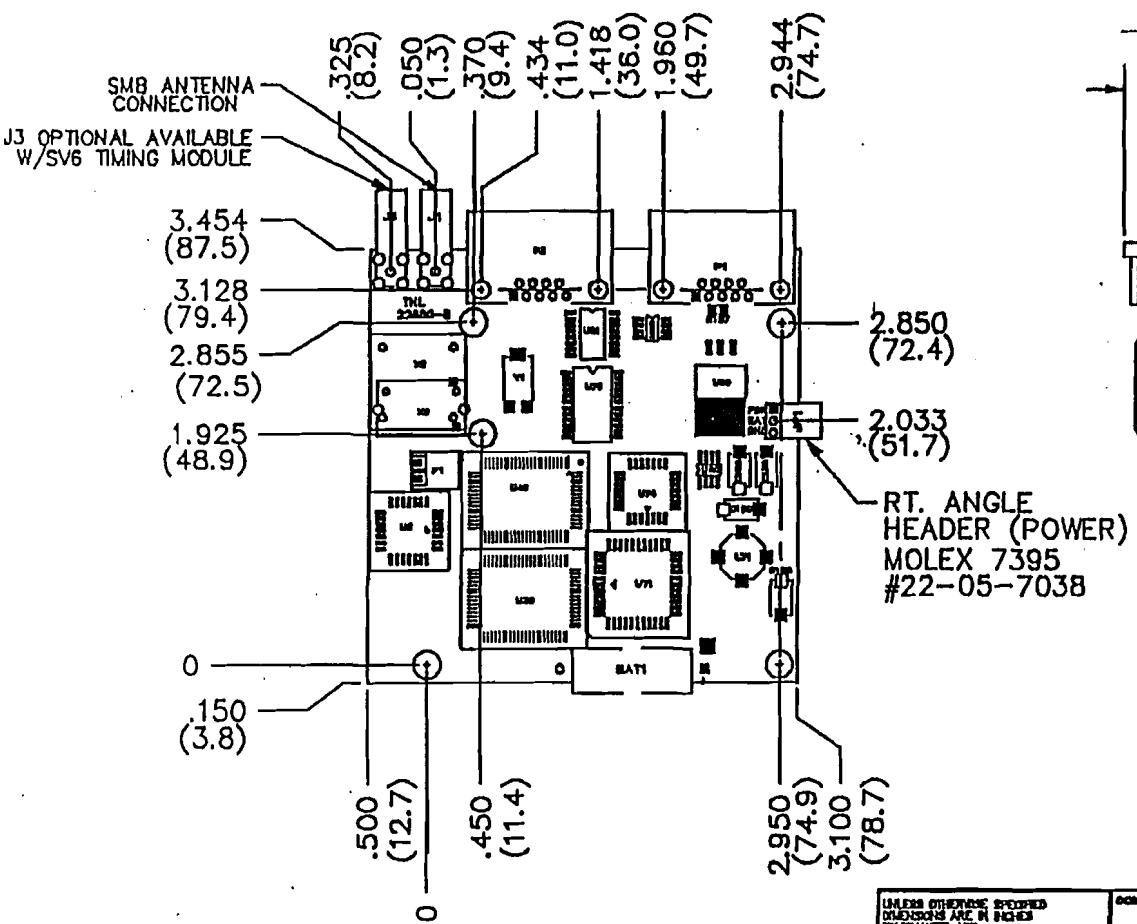
One Pulse Per Second

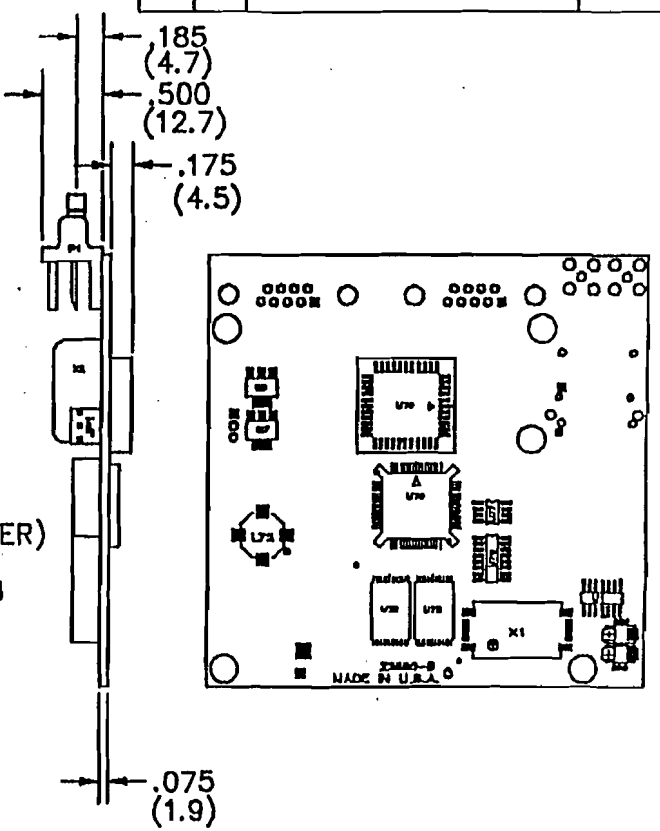
Timing	Leading edge of pulse synchronized to UTC within 1 microsecond, nominal
Pulse Width	1 microsecond wide pulse; falling edge is 20 nanoseconds or less, depending upon distributed capacitance in cable
Output	Open-collector

RF Interference

Jamming	Resistant to broad band noise jamming where jamming-to-signal power ratio is 20 dB or less, measured at the antenna/preamplifier interface when input signal is at -160 dBW
Burnout	Protected from damage by RF signals at frequencies 100 MHz or more from the L1 frequency (1575.42 MHz) with received power up to one watt at the antenna

REVISIONS				
ECN	REV	DESCRIPTION	DATE	APPROVED





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MATERIAL
FINISH
DO NOT SCALE DRAWING

CONTRACT NO.

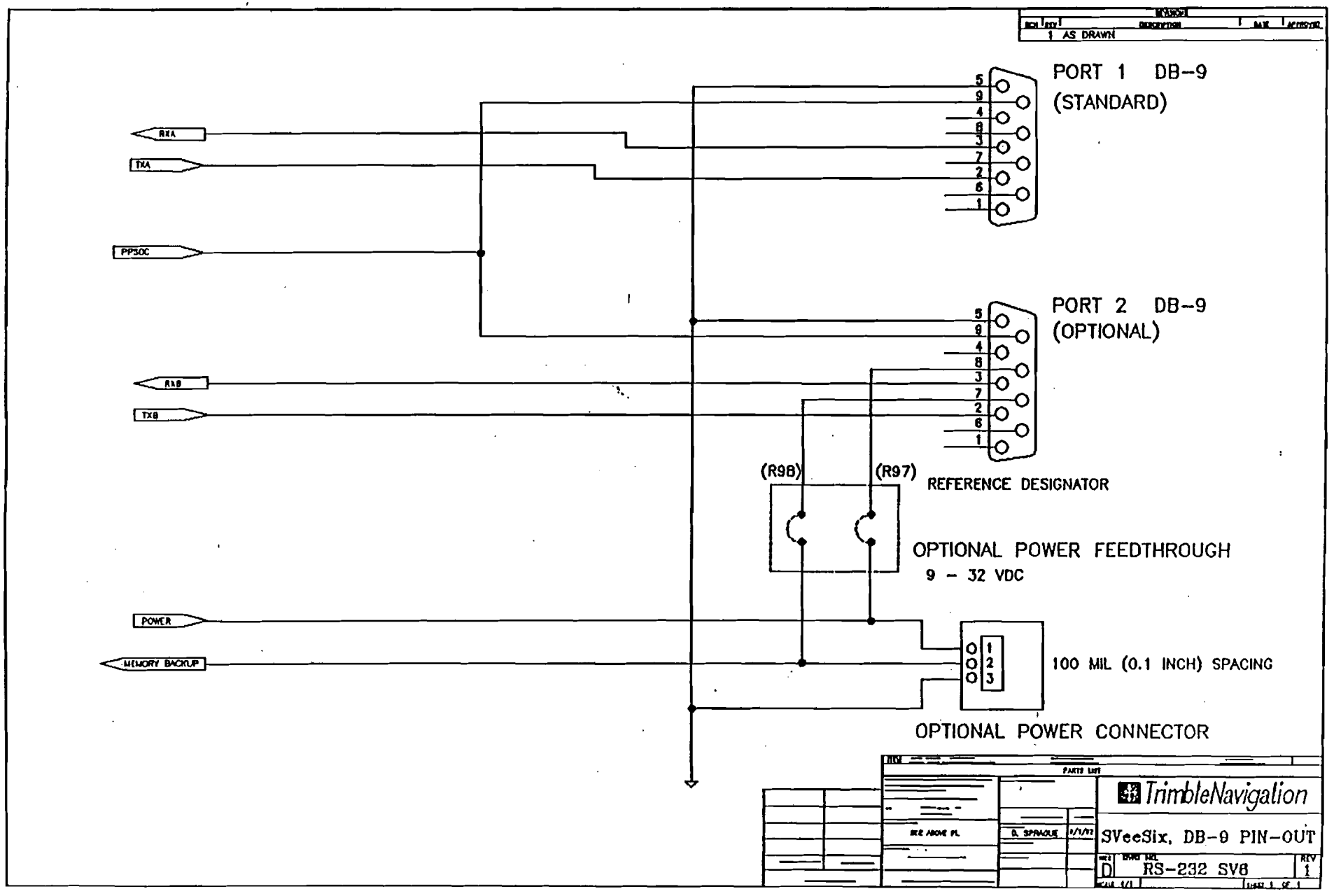
APPROVALS	DATE
DRAWN GARY THOMAS	8/8/94
CHECKED	
ISSUED	

Trimble Navigation

SVEE SIX BOARD
DUAL PORT

SIZE	FSCM NO.	DWG NO.	REV
B		22880-12-B	A

SCALE NONE SHEET 1 OF 1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DATE
APPROVED
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5
9
4
8
3
7
2
6
1
RXA
TXA
PPSOC
PORT 2 DB-9
(OPTIONAL)
RXB
TXB
(R98)
(R97)
REFERENCE DESIGNATOR
OPTIONAL POWER FEEDTHROUGH
9 - 32 VDC
POWER
MEMORY BACKUP
1
2
3
100 MIL (0.1 INCH) SPACING
OPTIONAL POWER CONNECTOR
TITLE
PARTS LIST
SEE ABOVE PL
D. SPRAGUE
9/1/97
TrimbleNavigation
SVeeSix, DB-9 PIN-OUT
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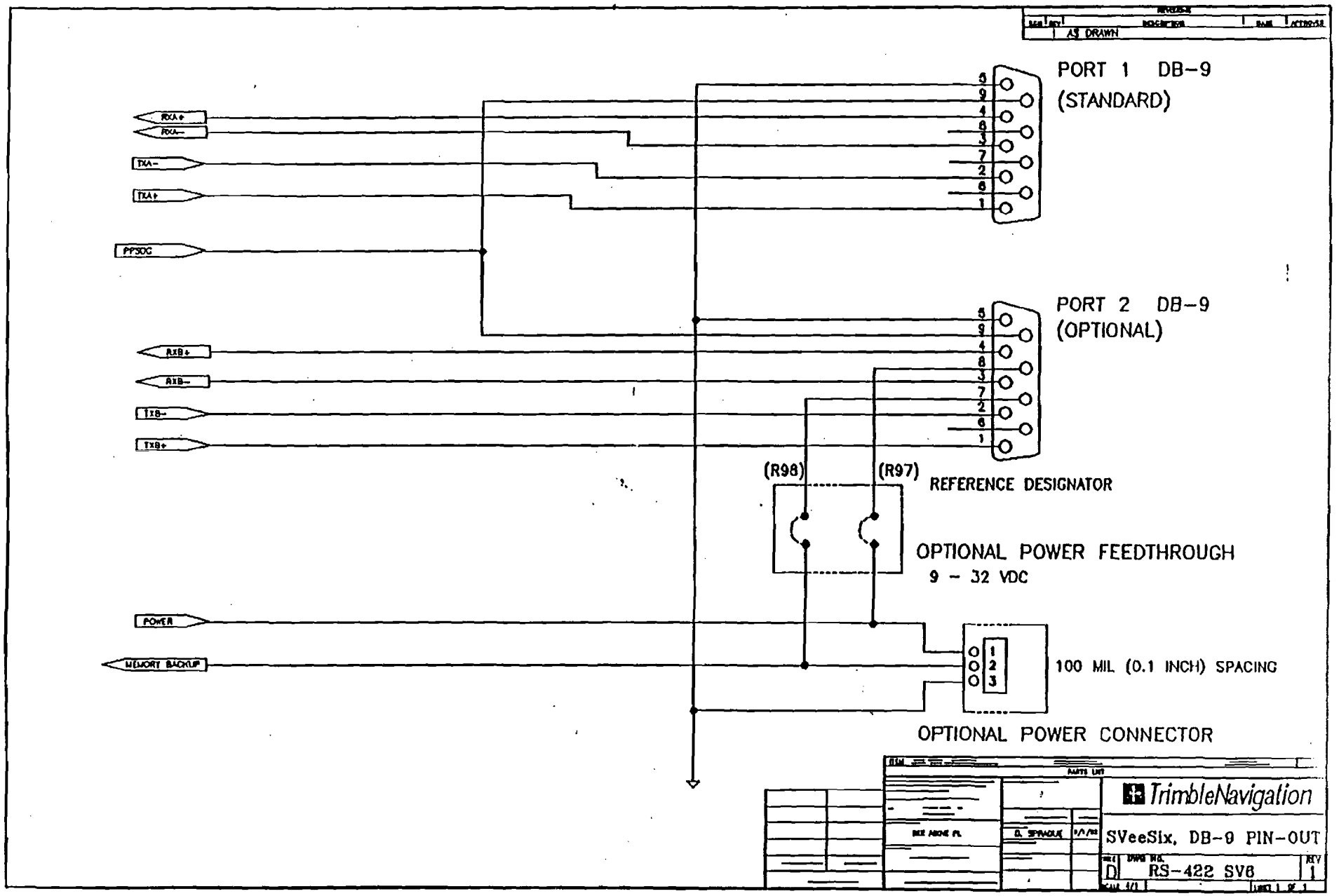
DWG NO.
REV
D
RS-232 SV6
1
SCALE 1/1
SHEET 1 OF 1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(STANDARD)
RXA+
RXA-
TXA-
TXA+
PP30C
PORT 2 DB-9
(OPTIONAL)
RXB+
RXB-
TXB-
TXB+
(R98)
(R97)
REFERENCE DESIGNATOR
OPTIONAL POWER FEEDTHROUGH
9 - 32 VDC
POWER
MEMORY BACKUP
1
2
3
100 MIL (0.1 INCH) SPACING
OPTIONAL POWER CONNECTOR
TrimbleNavigation
SVeeSix, DB-9 PIN-OUT
RS-422 SV6
REV
1