

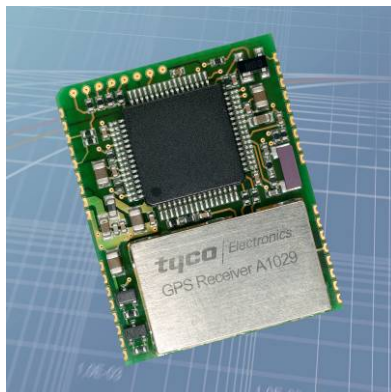


GPS Receivers A1029

**A description of Tyco Electronics'
GPS modules A1029-A/-C and A1029-B/-D
including Dead Reckoning interface**

User's Manual

**Version 4.0
Hardware Revision 04/05**



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Revision History

Rev.	Date	Description
1.0	11-10-03	Initial Draft.
1.1	11-24-03	Second draft – not released.
1.2	12-02-03	Preliminary version.
1.3	12-22-03	Minor format changes.
1.4	01-09-04	Gain select clarified, LOCK pin described, Overview Mechanics included.
1.5	01-15-04	Picture, description ENABLE pin.
1.6	02-16-04	Included picture minimum configuration.
1.7	03-01-04	Included antenna connection recommendations, tape drawings, removed Glossary (on web site).
1.8	04-15-04	Included solder pad proposal.
1.9	06-18-04	Complete review, important changes on VANT and 1PPS.
2.0	06-23-04	Introduced A1029-B.
2.1	07-16-04	Minor corrections after R&D review.
2.2	10-06-04	Minor corrections.
2.3	10-11-04	Format changes, correct pin-out of A1029B, added tray description on A1029-B.
2.4	02-23-05	Introduced new contact details.
3.0	07-01-05	Description of additional Dead Reckoning signal interface (HW version 02), added details for use of nRST signal.
3.1	11-10-05	Description of differences HW version 02 to old HW version 01 for A1029-A added.
3.2	02-17-06	More details added for signals.
3.2	03-03-06	Recommended minimum Configuration updated
3.3	04-25-06	New gyros for DR.
3.4	22-05-06	TCXO product versions –C and –D added.
3.5	11-28-06	Additional info “Connection of RF Signal”
3.6	12-08-06	Application note: Antenna current limiter
4.0	03-05-07	Application note nReset input, re-structuring, new design
	mm-dd-yy	

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Table of Contents

1 Introduction	7
1.1 Label	7
1.2 Dead Reckoning.....	8
1.3 Characteristics	8
1.4 Handling Precautions	9
2 Ordering Information	10
2.1 GPS Receiver A1029-A/-C and A1029-B/-D	10
2.2 Packing	10
2.2.1 Packaging of the A1029-A/-C	10
2.2.2 Packaging of the A1029-B/-D	11
2.3 Additional Equipment	12
3 Quick Start	13
3.1 Minimum Configuration	13
3.2 Antenna.....	14
3.3 Serial Port Settings	14
3.4 Improved TTFF	14
4 Mechanical Outline	15
4.1 Overview A1029-A/-C	15
4.1.1 Overall module dimensions	15
4.1.2 Details Component Side A1029-A.....	16
4.1.3 Details Solder Side A1029-A/-C	17
4.2 Overview A1029-B/-D	18
4.2.1 Overall module dimensions	18
4.2.2 Connector A1029-B/-D	18
5 Pin-out Information	19
5.1 Layout A1029-A/-C.....	19
5.2 Description A1029-A/-C Signals.....	20
5.3 Layout A1029-B/-D.....	22
5.4 Description A1029-B/-D Signals.....	23
5.5 General Comments	24
6 Dead Reckoning Interface	25
6.1 Odometer and Reverse Signals	25
6.2 Gyro and Gyro Signal.....	26
6.3 Power Supply for Internal ADC	28
6.4 Dead Reckoning Application	28
7 Electrical Characteristics	30
7.1 Operating Conditions	30
7.2 Absolute Maximum Ratings	30
8 Mounting	31

8.1 Proposed Footprint for Soldering	31
8.2 Recommended Profile for Reflow Soldering	32
9 Use of Antenna.....	33
9.1 Connection of RF Signal	33
9.2 Active Antenna	34
9.3 Passive Antenna	34
10 Quality and Reliability.....	35
10.1 Environmental Conditions	35
10.2 Product Qualification	35
10.3 Production Test.....	35
11 Applications and Hints	36
11.1 Minimum Configuration	36
11.2 Antenna Sensor Pin (ANTSTAT).....	36
11.2.1 Antenna Status Adaptation.....	36
11.3 Gain select pin (GS).....	38
11.4 VANT Pin (antenna voltage input pin).....	39
11.5 LOCK Pin (position fix pin)	40
11.6 ENABLE Pin (low-power mode)	40
11.7 1PPS pin (1 pulse per second pin).....	40
11.8 Reset Signal.....	41
11.9 Battery Back-up.....	42
11.9.1 Simple Example.....	43
11.9.2 Integrated solution	44
12 Demonstration Kits	45
12.1 USB Kit A1029-A/-C.....	45
12.2 Evaluation Kit A1029-A/-C	45
12.3 Demonstration Kit A1029-B/-D	45
13 Related Information	46
13.1 Contact.....	46
13.2 Related Documents.....	46
14 List of Tables	47
15 List of Figures	47

1 Introduction

Tyco Electronics' GPS modules A1029-A and A1029-C (TCXO version) are highly integrated GPS receiver modules and can be used as SMT components. They also serve as the basis for the GPS modules A1029-B and A1029-D (TCXO version), which are plug-in modules. All modules are capable of receiving signals from up to 12 GPS satellites and transferring them into position and timing information that can be read over a serial port. The A1029-C (and therefore the A1029-D) is using a TCXO (thermal compensated crystal oscillator) to improve TTFF by around 25% instead of a standard crystal used by the A1029-A. Basic characteristics:

- Operable at 3.3V / 50mA (typ.) @ 1fix per second
- Antenna sensor pin with defined current sensing range (for antenna detection or antenna short circuit detection)
- LNA Gain select pin (for adjustment to various RF signal conditions)

A1029-A/-C features:

- Small form factor of 22 x 28 mm (0.87" x 1.10")
- Cost-effective antenna input
- Single-sided SMD component, for reflow soldering
- Tape & reel packaging

A1029-B/-D features:

- Standard power and I/O connector
- Standard SMA bulk head antenna connector
- Mountable without solder process
- Field replaceable

Both GPS receiver are available as off-the-shelf components, 100% tested and shipped in either standard tape-and-reel package (A1029-A/-C) or in trays (A1029-B/-D).

1.1 Label

The A1029's labels hold the following information:

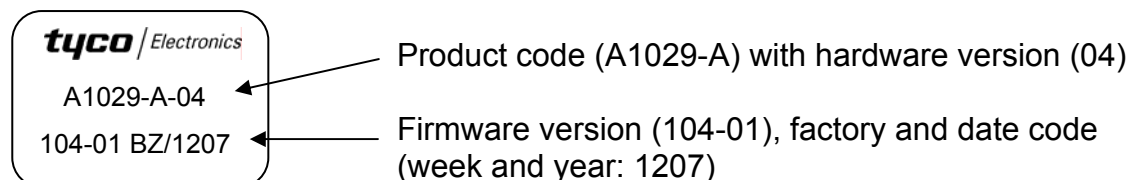


Figure 1: A1029 label

1.2 Dead Reckoning

Dead Reckoning capability was introduced with hardware version 02, which can be identified on the label. The extensions for the support of Dead Reckoning do not affect any other characteristics of the module. 100% backward electrical and mechanical compatibility is assured with one exception: In order to be able to support all necessary signals, the I/O connector of the A1029-B/-D was extended by two pins on each side (total of 4 pins) keeping the center pins (signals and position) identical. Therefore the connector plugs into existing designs based on the hardware version 01. Care must be taken that the real estate now covered by the additional pins is not populated on the carrier PCB.

1.3 Characteristics

The modules are characterized by the following parameters.

Channels		12, parallel tracking
Frequency		L1 (= 1575 MHz)
Position Accuracy	Stand alone	3m CEP (SA off)
	Differential	< 2m CEP
Time To First Fix – TTFF (theoretical minimum values; values in real world may differ)	Obscuration recovery ⁽¹⁾	1s
	Hot start ⁽²⁾	< 3s
	Warm ⁽³⁾	< 32s
	Autonomous / cold ^{(4) (6)}	< 60s
	Power-off start ^{(5) (6)}	Varying

Table 1: A1029 characteristics

- (1) The calibrated clock of the receiver has not stopped, thus it knows precise time (to the μ s level).
- (2) The receiver has estimates of time/date/position and valid almanac and ephemeris data.
- (3) The receiver has estimates of time/date/position and recent almanac.
- (4) The receiver has no estimate of time/date/position, and no recent almanac.
- (5) Receiver is powered off, clock stops. Start-up time depends on time passed since power-off and power-on location.
- (6) In order to improve TTFF, the receiver allows setting of time/date/position.

A1029-A/-C Mechanical dimensions	Length	28mm, 1.10"
	Width	22mm, 0.87"
	Height	3.2mm, 0.12"
A1029-A/-C Weight		2g, < 0.1oz

A1029-B/-D Mechanical dimensions	Length	33.0mm, 1.3"
	Width	45.7mm, 1.8"
	Height	4.5mm, 0.18"
A1029-B/-D Cable	Length	~100mm, ~4.0"
A1029-B/-D Weight		11g, 0.5oz

Table 2 and 3: A1029-A/-C and A1029-B/-D dimensions and weight

1.4 Handling Precautions

The GPS receiver modules A1029-A/-C and A1029-B/-D are modules that are sensitive to electrostatic discharge (ESD). Please handle with appropriate care.

2 Ordering Information

2.1 GPS Receiver A1029-A/-C and A1029-B/-D

The order numbers are built as follows:

- **V23993A1029Axxx**
- **V23993A1029Bxxx**
- **V23993A1029Cxxx**
- **V23993A1029Dxxx**

V23993 stands for Tyco Electronics wireless and communication products, A1029A for the A1029-A module, A1029B for the A1029-B module, A1029C for the A1029-C module, A1029D for A1029-D module, respectively. The “xxx” stands for the according firmware version. Where

- “1xx” is standard GPS software
- “2xx” is GPS software with Dead Reckoning support

The functionality of both software versions is reflected in the according manuals.

2.2 Packing

2.2.1 Packaging of the A1029-A/-C

The A1029-A/-C GPS module comes in a tape and reel package suitable for pick and place machines.

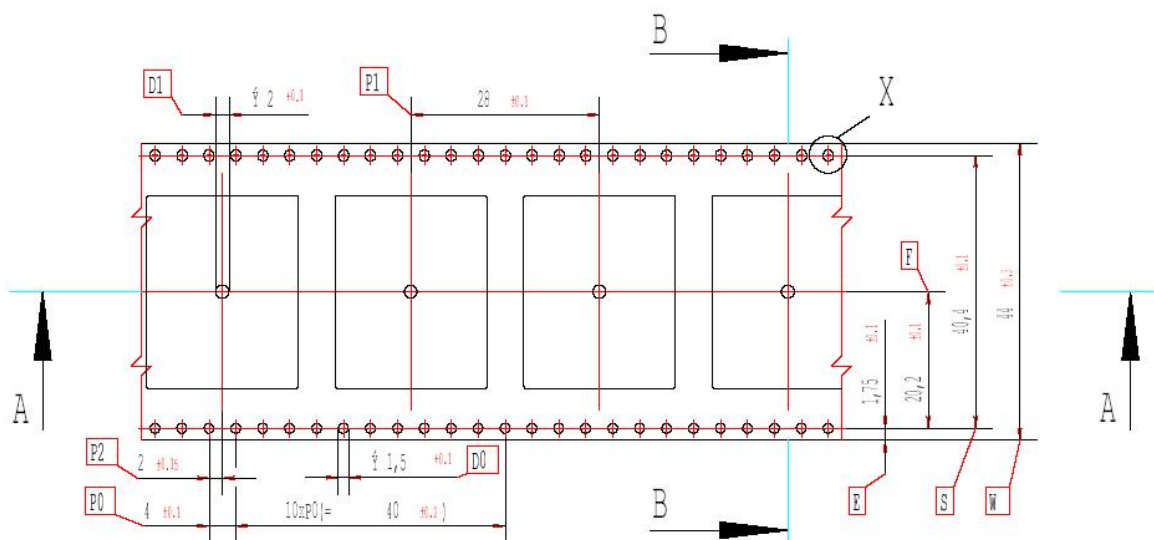


Figure 2: A1029-A/-C tape specifications (1)

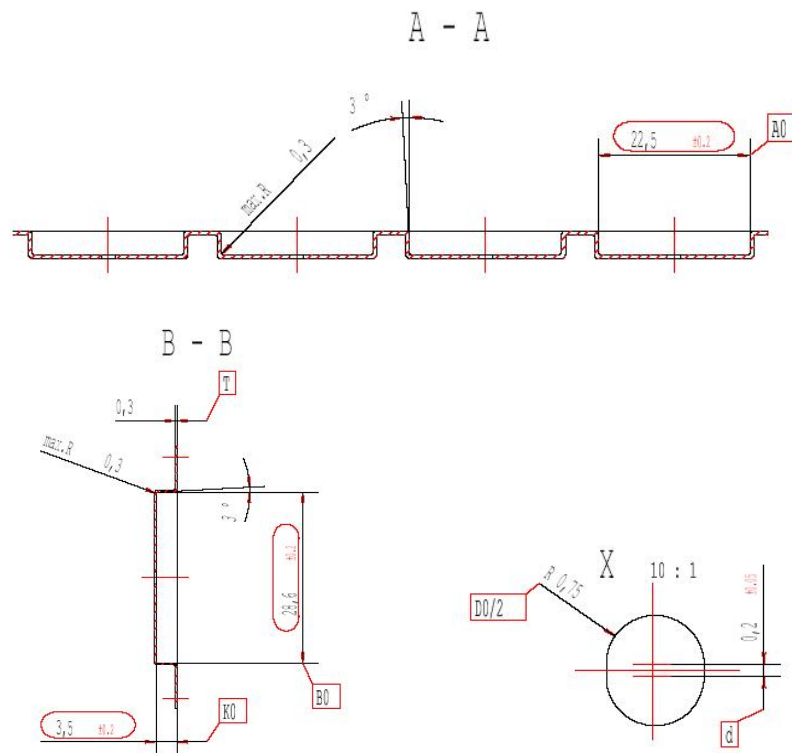


Figure 3: A1029-A/-C tape specifications (2)

2.2.2 Packaging of the A1029-B/-D

The A1029-B/-D comes in trays, with 12 modules per tray.

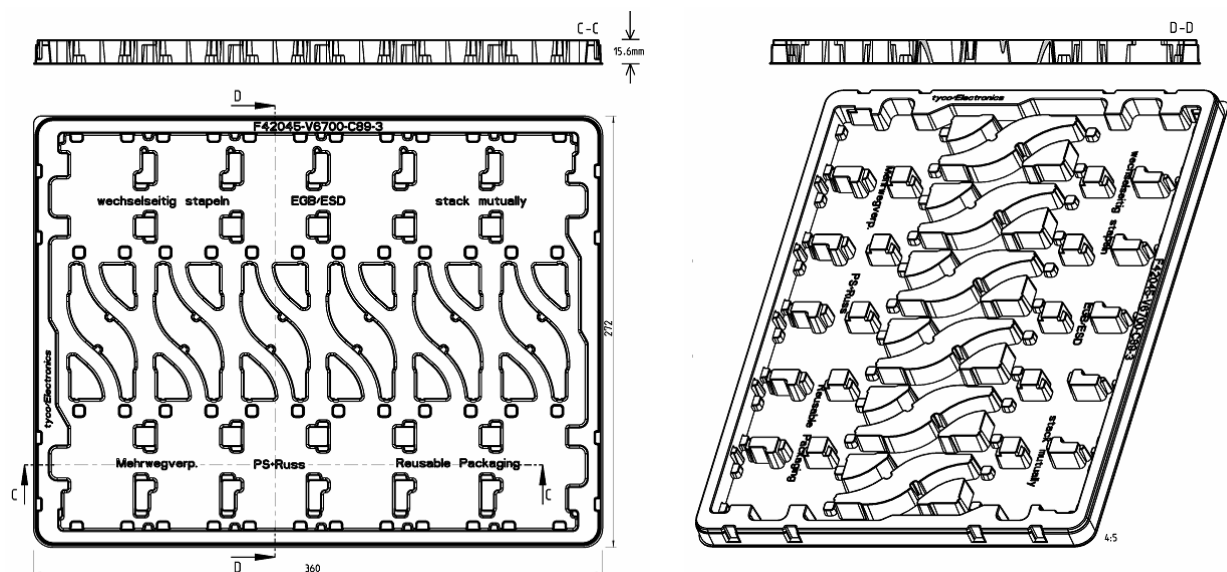


Figure 4: A1029-B/-D tray specification

2.3 Additional Equipment

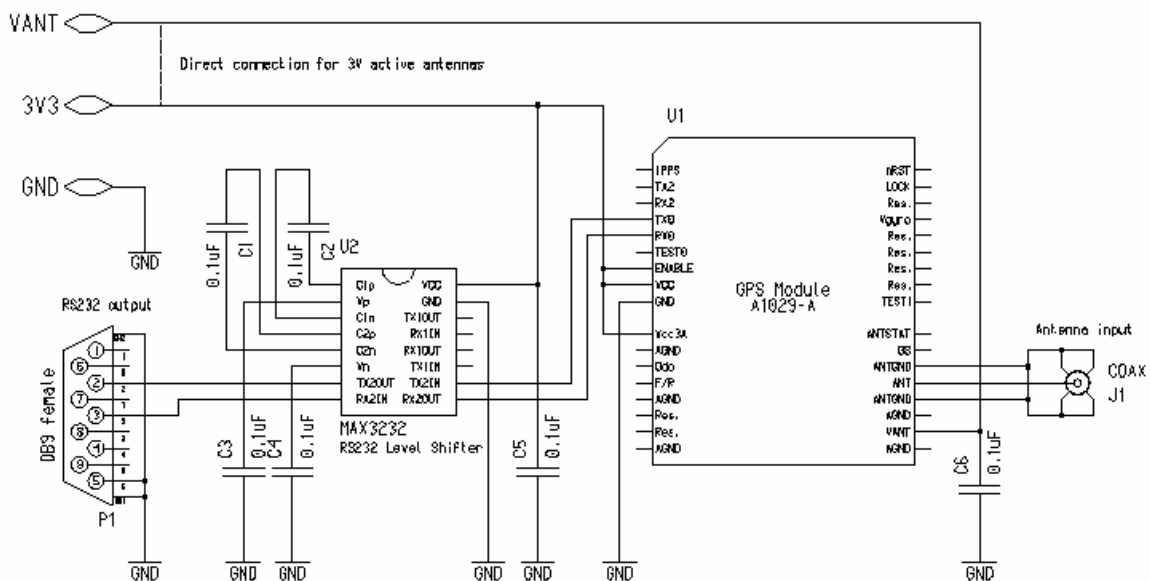
V23993USB1029A	Demonstration Kit (including one module V23993A1029A)
V23993USB1029C	Demonstration Kit (including one module V23993A1029C)
V23993EVA1029A	Evaluation Kit (including one module V23993A1029A)
V23993EVA1029C	Evaluation Kit (including one module V23993A1029C)
V23993DKS1029B	Demonstration Kit (including one module V23993A1029B)
V23993DKS1029D	Demonstration Kit (including one module V23993A1029D)
V23993DR1030A	Dead Reckoning Demonstration Kit (including one module V23993A1030B) – functionality compatible to A1029A/B/C/D Dead Reckoning solution.

Table 4: Additional equipment

Detailed descriptions of the additional kits can be found in the according manuals.

In order to allow an easy and quick start with the modules A1029-A/-C or A1029-B/-D, this chapter provides a short overview on the most important steps to receive NMEA messages with position information on a serial port. For details please refer to the according chapters.

The following picture shows a recommended minimum configuration for NMEA output and commands received and sent via an RS232 interface based on the A1029-A/-C. The configuration for the A1029-B/-D has to be set up accordingly, using the same pins on the module. Here it is not necessary to provide an antenna connection on the motherboard, as a cable and connector is already provided with the module itself.



Remarks:

- Place C1 to C5 close to MAX3232. For capacity values see datasheet of actual component used.
- Place C6 close to module pin.
- Use 3.3V level shifter (MAX3232 or equivalent).
- Use separate ground plane for antenna ground.
- Antenna input impedance is 50Ohm. Match as close as possible.
- Maximum allowed antenna current is 50mA. Consider a current limiter.

- A battery back-up circuit for the RTC (Real Time Clock) should be considered (see 11.9 Battery Back-up)!
- In case of a long rise time of the external Vcc signal, a reset controller should be considered (see 11.8 Reset Signal)!

3.2 Antenna

It is recommended to use an active GPS antenna with supply voltage of 3 to 5VDC and a current draw of 50mA maximum. The quality of the GPS antenna chosen is of paramount importance for the overall sensitivity of the GPS system. An active antenna should have a gain $\geq 20\text{dB}$ and a noise figure $\leq 1.5\text{dB}$, which applies to more than 95% of the active antennas available in the market.

3.3 Serial Port Settings

The default configuration within the standard GPS firmware is:

- Serial 0 (NMEA) 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control
- Serial 2 (RTCM) 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control

The default configuration within the Dead Reckoning GPS firmware is:

- Serial 0 (NMEA) 57600 baud, 8 data bits, no parity, 1 stop bit, no flow control

3.4 Improved TTFF

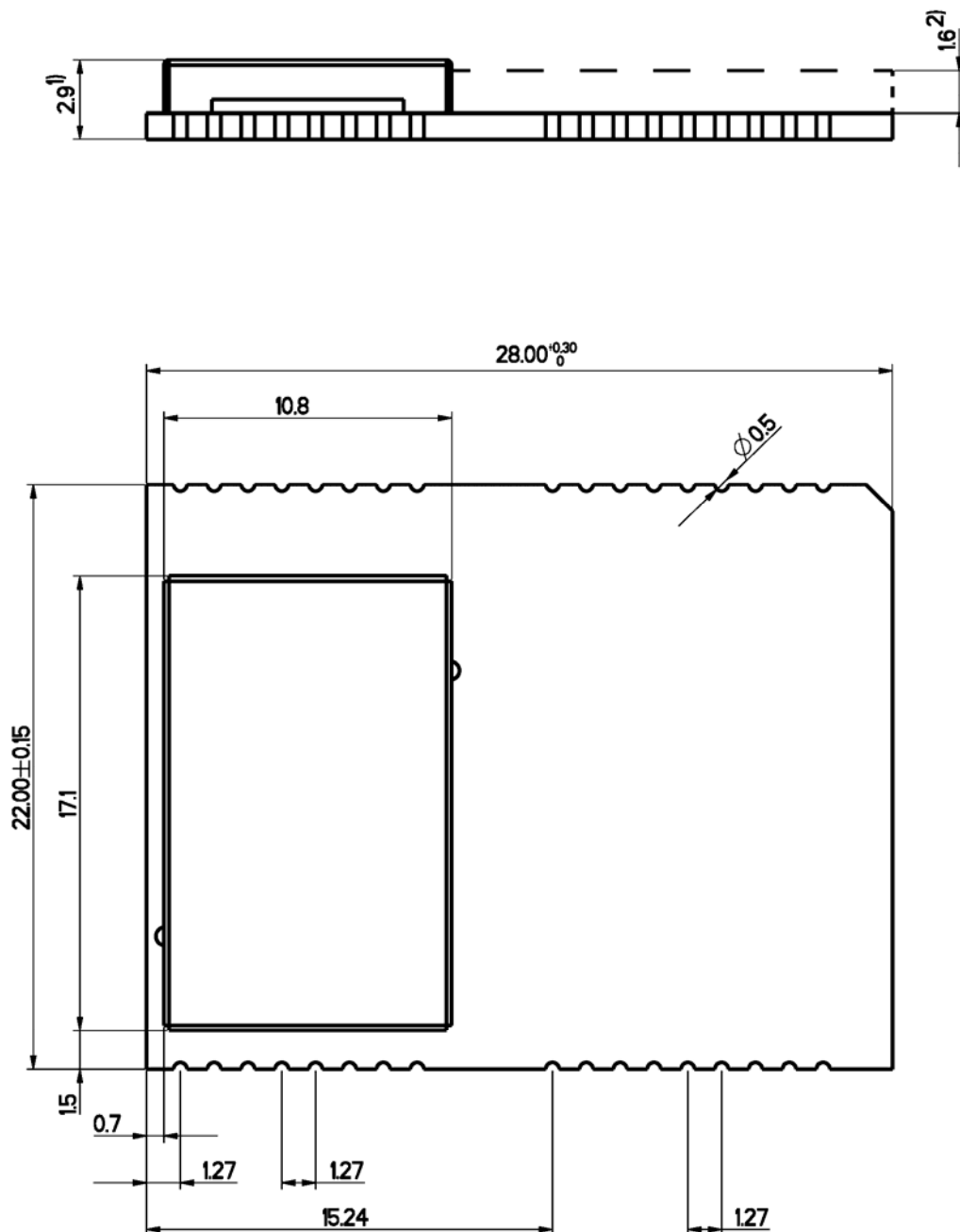
In order to improve the TTFF (Time To First Fix), it is recommended to support the RTC with a back-up battery when no system power is available. Standard operation mode is entered with the ENABLE pin on HIGH level. With the ENABLE pin on LOW level, low power mode will be entered. If still power is being supplied to Vcc, the RTC keeps on running while the internal processors will be stopped. The power consumption will drop from typically 50mA to typically 30 μ A. Please see also paragraph 11.6 ENABLE Pin (low-power mode).

If the system or the GPS receiver alone should not be backed-up it is possible to support the restart procedure by providing position and date/time information to the module. This is described in the firmware manual. Please refer there to chapter "Start-up Support" in the document T.E. GPS Firmware A1029.

4 Mechanical Outline

4.1 Overview A1029-A/-C

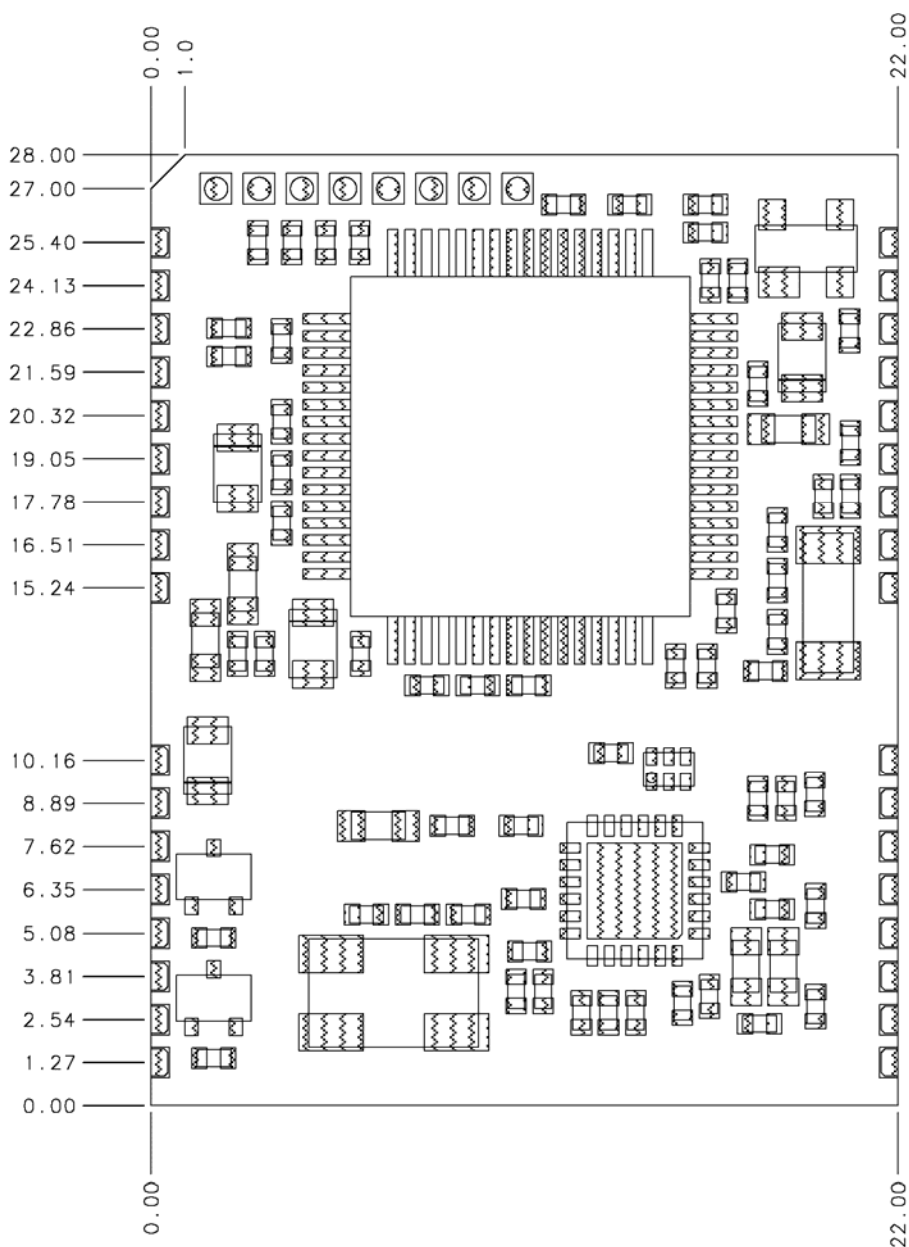
4.1.1 Overall module dimensions



All dimensions in [mm], 1) Minimum, 2) Maximum

Figure 6: Mechanical outline overview A1029-A/-C

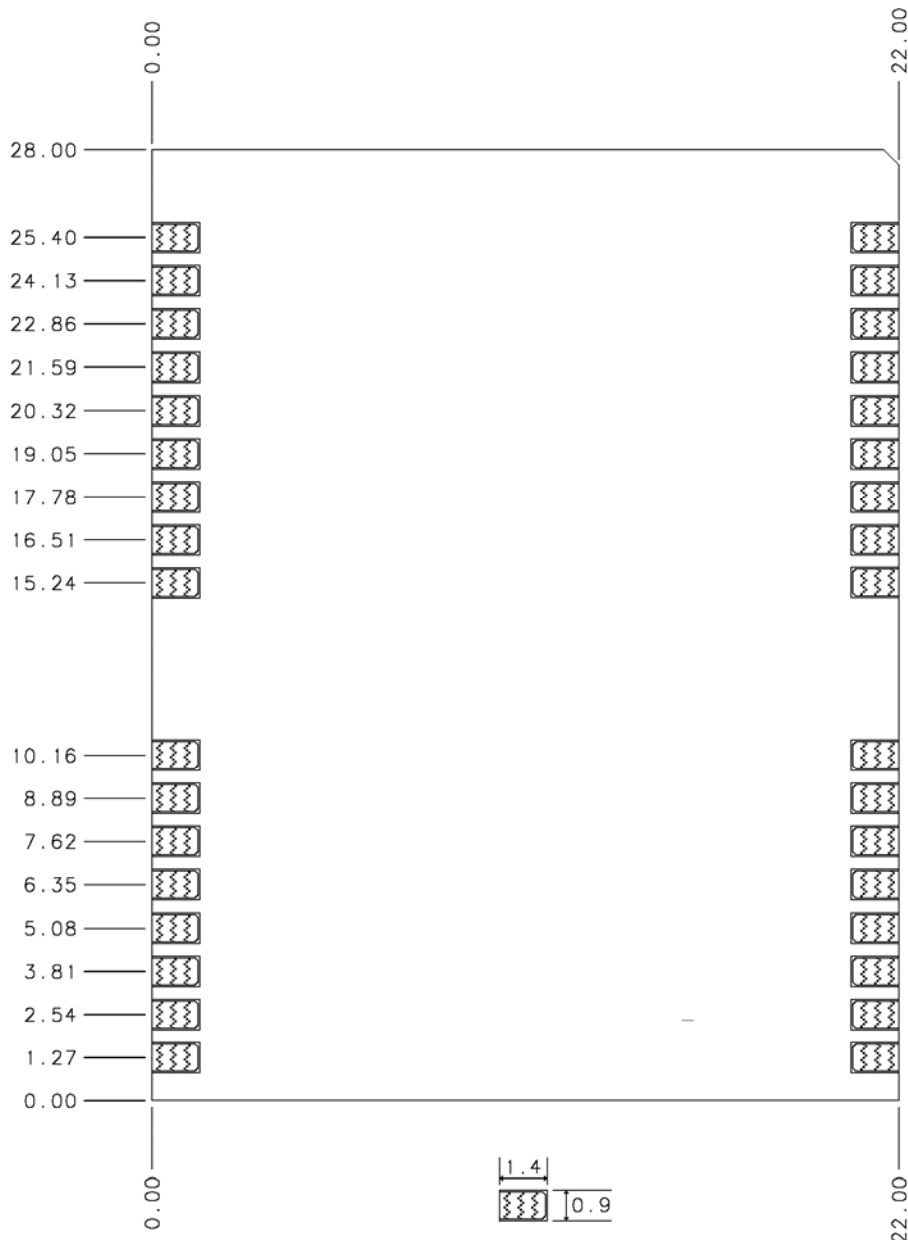
4.1.2 Details Component Side A1029-A



All dimensions in [mm]

Figure 7: Mechanical outline component side A1029-A/-C

4.1.3 Details Solder Side A1029-A/-C



Solder pad size: 1.4 x 0.9

Width including solder pads: 22

Distance between solder pads within groups 1-9, 10-17, 18-25, 26-34: 1.27

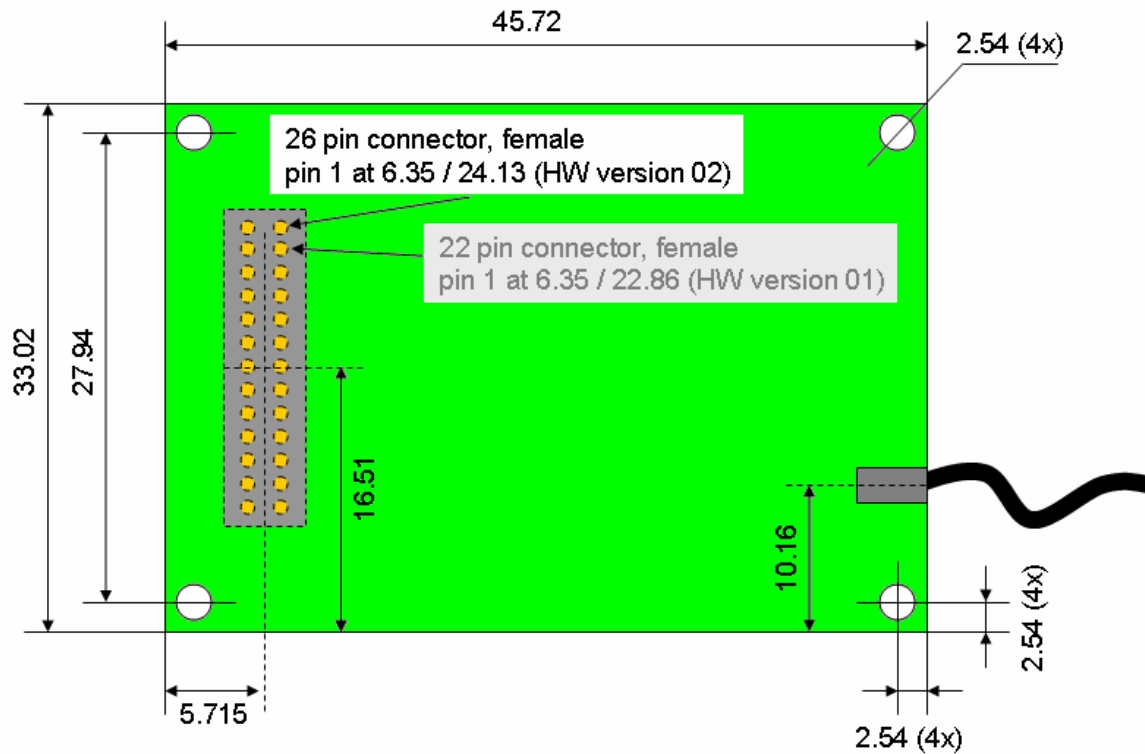
Distance between groups (1-9 to 10-17 and 18-25 to 26-34): 5.08

All dimensions in [mm]

Figure 8: Mechanical outline solder side A1029-A/-C

4.2 Overview A1029-B/-D

4.2.1 Overall module dimensions



All dimensions in [mm]

Figure 9: Mechanical outline overview A1029-B/-D

4.2.2 Connector A1029-B/-D

The power and I/O connector used on the A1029-B/-D is a 1.27mm (0.05") low profile, double row socket with a height of 2.21mm (.087") and a total of 26 contacts on HW version 02 and higher (used to be 22 on HW version 01). Potential counterparts on the motherboard are e.g. Samtec 1.27mm (0.05") micro strips of the FTS series (e.g. FTS-113-02-L-D).

5 Pin-out Information

5.1 Layout A1029-A/-C

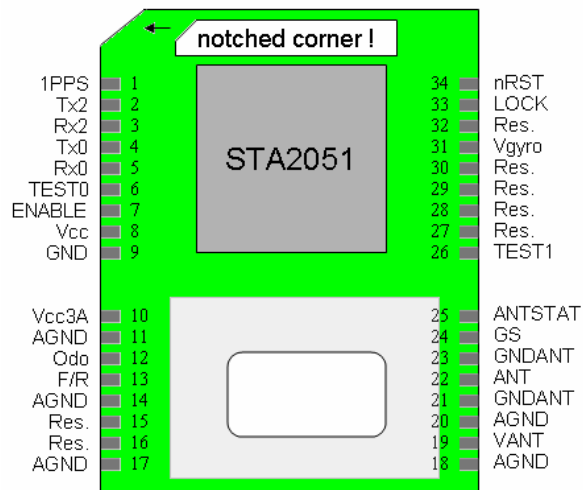


Figure 10: Pin-out information A1029-A/-C (top view)

5.2 Description A1029-A/-C Signals

These tables describe the functionality of the pins and their associated symbols. Signals required for Dead Reckoning (when according firmware is enabled) are marked with .

Pin	Symbol	Description
1	1PPS	1PPS (pulse per second) output
2	TX2	Serial output 2
3	RX2	Serial input 2, RTCM input (DGPS)
4	TX0	Serial output 0, NMEA out
5	RX0	Serial input 0, NMEA in
6	TEST0	Reserved for test purposes – do not connect
7	ENABLE	Enable pin – low power when low
8	Vcc	+3.3V (power supply)
9	GND	Ground (power supply)
10	Vcc3A	Analog voltage supply: For standard GPS functionality connect to Vcc. For DR < +3.3V (see below).
11	AGND	Analog ground For standard GPS functionality leave open. For DR connect to according analog GND.
12	Odo	Odometer input (required for DR, otherwise leave open)
13	F/R	Reverse signal input (required for DR, otherwise leave open)
14	AGND	Analog ground - see above
15	Res.	Reserved – do not connect
16	Res.	Reserved – do not connect
17	AGND	Analog ground - see above

Table 5: Pin description A1029-A/-C (part 1)

Pin	Symbol	Description
34	nRST	Reset input
33	LOCK	Activated on LOCK (position fix)
32	Res.	Reserved
31	Vgyro	Input pin for gyro output voltage For standard GPS functionality leave open. For DR connect to gyro output (see below).
30	Res.	Reserved
29	Res.	Reserved
28	Res.	Reserved
27	Res.	Reserved
26	TEST1	Reserved for test purposes
25	ANTSTAT	Antenna sensor output
24	GS	Gain Select for LNA – leave open
23	GNDANT	Antenna Ground, do not connect to GROUND, connect to antenna shield (see below)
22	ANT	Antenna signal / Z=50 Ohm
21	GNDANT	Antenna Ground, do not connect to GROUND, connect to antenna shield (see below)
20	AGND	Analog ground - see above
19	VANT	Power supply antenna – provide according voltage.
18	AGND	Analog ground - see above

Table 6: Pin description A1029-A/-C (part 2)

Pins 10 thru 17 used to be all AGND pins on HW version 01, pin 31 used to be a “Res.” pin on HW version 01. For use without Dead Reckoning, no design modification is necessary.

5.3 Layout A1029-B/-D

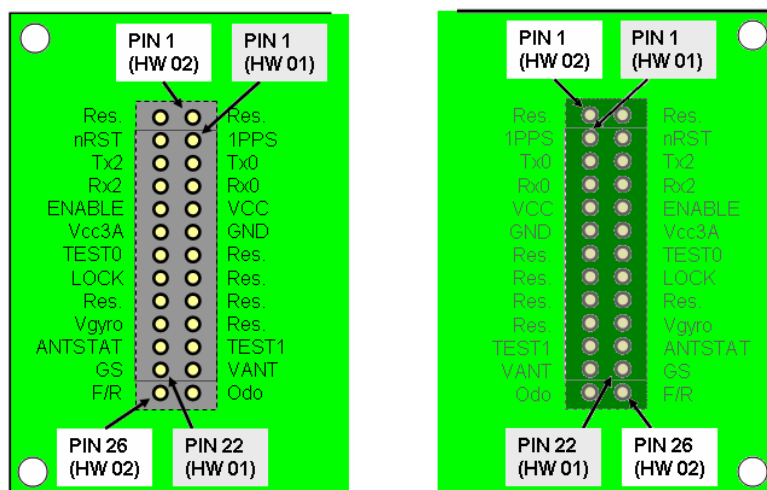


Figure 11: Pin out information A1029-B/-D (bottom and top view)

Bottom view is showing the side of the module that will face the carrier board.

5.4 Description A1029-B/-D Signals

These tables describe the functionality of the pins and their associated symbols. Signals required for Dead Reckoning (when according firmware is enabled) are marked with .

Pin (HW 02)	Pin (HW 01)	Symbol	Description
1		Res.	Reserved – do not connect
3	1	1PPS	1PPS (pulse per second) output
5	3	TX0	Serial output 0, NMEA out
7	5	RX0	Serial input 0, NMEA in
9	7	Vcc	+3.3V (power supply)
11	9	GND	Ground (power supply)
13	11	Res.	Reserved – do not connect
15	13	Res.	Reserved – do not connect
17	15	Res.	Reserved – do not connect
19	17	Res.	Reserved – do not connect
21	19	TEST1	Reserved for test purposes – do not connect
23	21	VANT	Power supply antenna – provide according voltage.
25		Odo	Odometer input (required for DR, otherwise leave open)

Table 7: Pin description A1029-B/-D (part 1 – odd pin row)

Pin (HW 02)	Pin (HW 01)	Symbol	Description
2		Res.	Reserved – do not connect
4	2	nRST	Reset input
6	4	TX2	Serial output 2
8	6	RX2	Serial input 2, RTCM input
10	8	ENABLE	Enable pin – low power when low
12	10	Vcc3A	Analog voltage supply: For standard GPS functionality connect to Vcc. For DR < +3.3V (see below).
14	12	TEST0	Reserved for test purposes – do not connect
16	14	LOCK	Activated on LOCK (position fix)
18	16	Res.	Reserved – do not connect
20	18	Vgyro	Input pin for gyro output voltage For standard GPS functionality leave open. For DR connect to gyro output (see below).
22	20	ANTSTAT	Antenna sensor output
24	22	GS	Gain Select for LNA – leave open
26		F/R	Reverse signal input (required for DR, otherwise leave open)

Table 8: Pin description A1029-B/-D (part 2 – even pin row)

Pins 12 and 20 on HW version 02 and higher used to be “Res.” pins on HW version 01 (there numbered 10 and 18). For use without Dead Reckoning, no design modification is necessary.

5.5 General Comments

The following comments should be considered for a design with and use of the module:

- Standard configuration of serial port (standard GPS software):
Serial 0 (NMEA) 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control
Serial 2 (DGPS) 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control
- Standard configuration of serial port (DR software):
Serial 0 (NMEA) 57600 baud, 8 data bits, no parity, 1 stop bit, no flow control
- Antenna (Antenna connected to Antenna Pin – A1029-A/-C only)
Use ground pins (pin 21, pin 23) close to the antenna input for RF ground.
- Gain Select
Default setting is “open” (identical to logical low), which results in a high gain (14dB). This setting is recommended.
- nRST
Do not pull low when in low power mode (ENABLE = LOW)
- Vcc3A
Power supply of internal ADC. This feature is not used, but it is recommended to connect to Vcc.

6 Dead Reckoning Interface

Dead Reckoning (DR) functionality requires the correct firmware (“2xx”) and the correct hardware set-up on the main board. Two digital signals (odometer and reverse), a gyro and according power supply for the internal ADC are necessary to support this feature. This chapter shall provide all necessary information for designing an according main board. The recommendations here assume the availability of a 5V (V_{CC5D}) and 3.3V (V_{CC3D}) digital power supply on this main board.

6.1 Odometer and Reverse Signals

Both signals are provided by the vehicle. In order to connect the signals in the correct way to the module, they should be optically isolated. The following schematic is an example on how an implementation could look like.

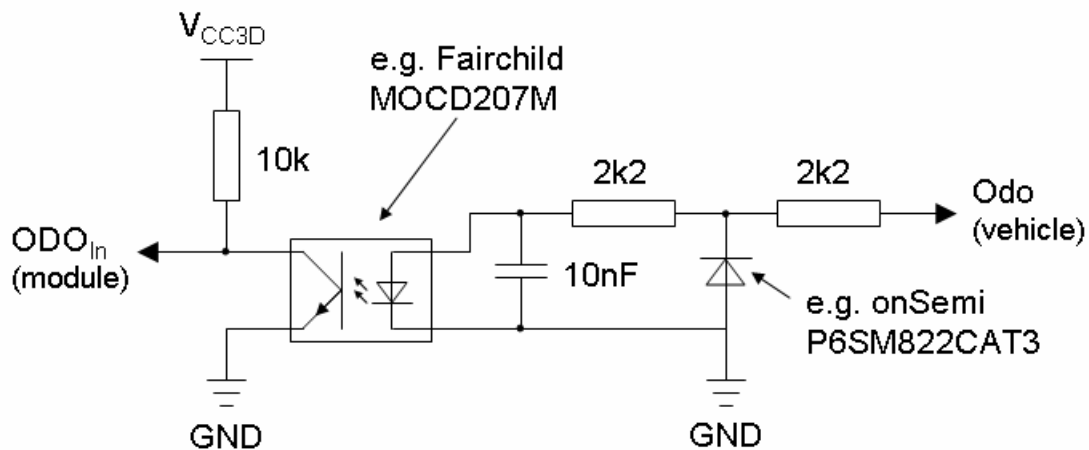


Figure 12: Connecting an odometer signal

The same configuration can be used for the reverse signal.

6.2 Gyro and Gyro Signal

The gyro is of utmost importance for the performance of the DR system. The following data shall provide a guideline for selecting the right gyro:

Basic gyro data

- Supply voltage: 5V (more gyros available, also used in the example) or 3V
- Current draw: < 20mA
- Max. angular velocity: ± 80 deg./s
- Output at angular velocity 0: 1.5V (or 2.5V and according divider, as shown in the example)
- Resolution: ~ 0.1 deg/sec
- Scale factor: $\sim 25\text{mV} / \text{deg} / \text{s}$ (smaller values possible, e.g. $12.5\text{mV} / \text{deg} / \text{s}$ at supply voltage 3V)

Important for system performance as well:

- Temperature coefficient of scale factor: max. $\pm 10\%$ at -30° to $+80^\circ\text{C}$
- Linearity: $\pm 0.5\%$ full scale
- Offset drift: e.g. Melexis MLX90609-N $\pm 2.5\%$ of Zero Rate Output at 25° (smaller values desirable)
- Response: max. 10Hz
- Noise level; max. 10mVp-p

In the example (also on the DR1030A board), the Melexis MLX90609-N is used, a 5V gyro with an output of 2.5V at $0^\circ/\text{s}$ angular velocity. To allow the complete output range to fit into the input range of the internal ADC, a 2:1 divider is integrated.

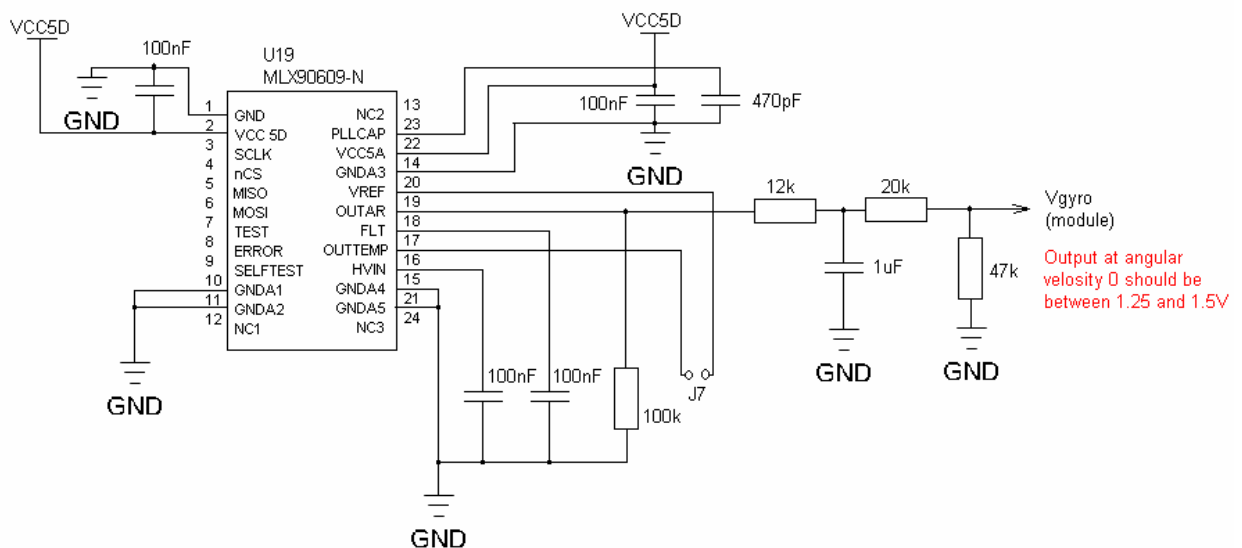


Figure 13: Connecting the gyro Melexis MLX90609-N
(recommended solution)

Other comparable gyros are Murata MEV50A or Analog ADXRS401.

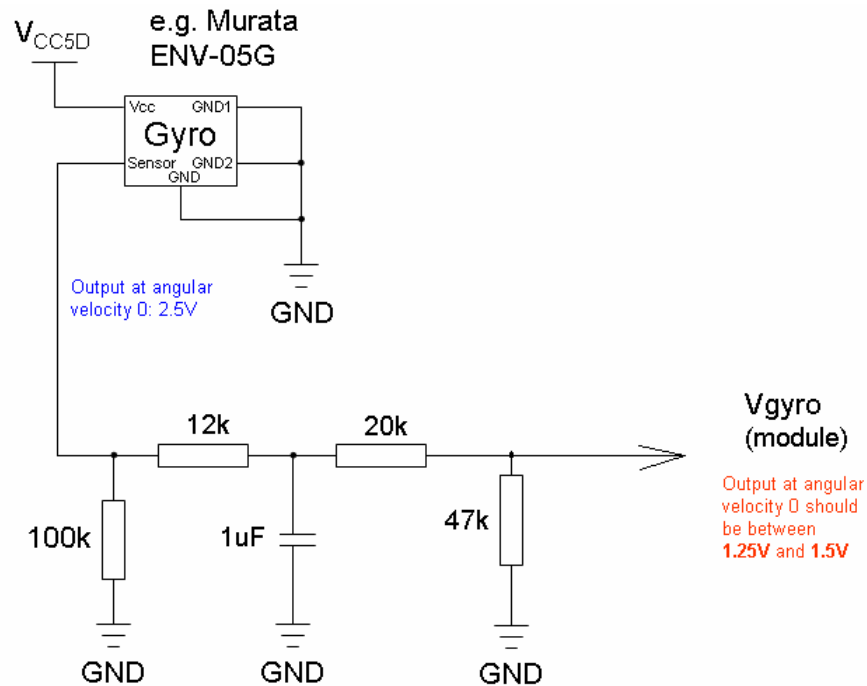


Figure 8: Connecting the gyro Murata ENV-05G
(Attention: not recommended for new designs, but to illustrate the principle)

A one-to-one replacement that is available for new designs is the Panasonic EWTS86NN21.

6.3 Power Supply for Internal ADC

The internal ADC requires a separate power supply on pin Vcc3A. The power should be derived from the same source that is used for the gyro. This way, oscillations of the power source affect the gyro and the ADC and therefore minimize the negative effects. It is also recommended that Vcc3A is slightly below the power supplied to module (Vcc).

The following circuit shows an example on how to generate the power for the internal ADC from a 5V source.

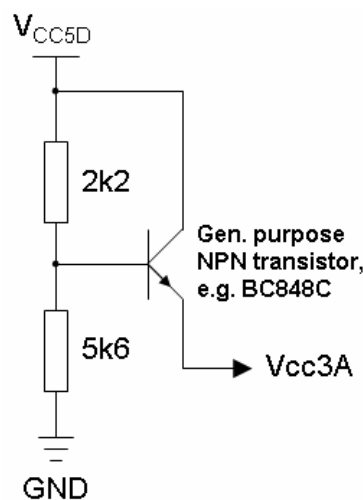


Figure 14: Power supply for internal ADC (Vcc3A)

6.4 Dead Reckoning Application

In comparison to the A1030-A the A1029-A/-C or A1029-B/-D do not offer external SRAM that can be backed-up with a battery. Therefore the current calibration and Kalman state data need to be stored using a command:

- \$PTYCDRSAVE: Store the actual Kalman data

It is utterly important for the performance after start-up to issue this command right before power is switched off. As a result the current calibration and Kalman state data will be stored into flash memory. After restart, these data are immediately available and as a consequence all Dead Reckoning calculations are very precise from the beginning!

If this command was not issued before switching off the power or in case the vehicle was moved and the Dead Reckoning unit was switched off and is switched on later on only (e.g. transport of car by train or ferry), send the following commands in this order to the system:

- \$PTYCDRERASE : Erase calibration data in int. FLASH

Note: This will require a new calibration!

Otherwise for any details on the Dead Reckoning firmware implementation, please refer to the “T.E. GPS Firmware DR A1030” document. All other aspects, especially the integration and calibration process are identical. It has to be considered that the A1029 Dead Reckoning firmware does not support SBAS or Data Logging.

7 Electrical Characteristics

7.1 Operating Conditions

Pin		Description	Min	Typical	Max
AC	BD				
8	9	Vcc	3.0V	3.3V	3.6V
		Current draw (without active Antenna)		50mA	
		Input current in standby mode		30μA	
1	3	1PPS (1 pulse per second), reference GPS time (active and passive antenna)		+120ns +90ns	
19	23	VANT (active antenna supply voltage) Antenna current	Vcc-0.5V		5.2V 50mA
22	na	ANT (antenna pin)		Z ₀ =50Ω	
24	24	GS (gain select for LNA), input pin GS high (Low gain – 4dB) GS low (high gain – 14dB)	Vcc-0.6V		Vcc 0.6V
25	22	ANTSTAT (antenna sensor output) @ 1mA current source (antenna current values are typical values) High at antenna current from 9 to 16mA Low at antenna current <9mA or >16mA	Vcc-0.5V 0		Vcc 0.5V
		Output pins VOH VOL	Vcc-0.8V		0.4V
		Input pins VIH VIL	0.7Vcc		0.3Vcc

Table 9: Operating Conditions

7.2 Absolute Maximum Ratings

Pin		Description	Min	Max
AC	BD			
8	9	Vcc	-0.3V	3.6V
		Current Antenna, external power supply		50mA
		Applied voltage to all input pins excluding VCC, VANT	-0.3V	Vcc+0.3V max. 3.6V

Table 10: Absolute maximum ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

8 Mounting

This chapter covers the mounting of the A1029-A/-C. The A1029-B/-D offer a power and I/O connector with a 1.27mm (0.05") low profile, double row socket with a total of 26 contacts (on HW version 02 and higher or 22 contacts on HW version 01). Potential counterparts on the motherboard are Samtec 1.27mm (0.05") micro strips of the FTS series. For fixing the A1029-B/-D on a motherboard appropriate screws and bolts or clips (see also chapter 4.2 Overview A1029-B/-D) are recommended.

8.1 Proposed Footprint for Soldering

The following proposal of a footprint for soldering is assuming a stencil thickness of 150µm. ✕ marks the center of the through holes.

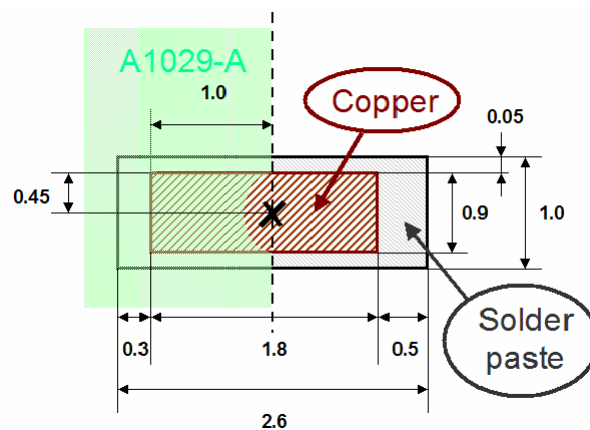


Figure 15: Soldering footprint proposal A1029-A/-C

The final footprint has to be evaluated and qualified by the manufacturer according to the specific processes.

8.2 Recommended Profile for Reflow Soldering

Typical values for reflow soldering of the module in convection or IR/convection ovens are as follows:

Peak temperature (RoHS compliant process)	245°C
Average ramp up rate to Peak (183°C to Peak)	3°C / second max.
Preheat temperature 125 ($\pm 25^\circ\text{C}$)	120 seconds max.
Temperature maintained above 183°C	60 ... 150 seconds
Time within 5°C of actual peak temperature	10 ... 20 seconds
Ramp Down rate	6°C / second max.
Time 25°C to peak temperature	6 minutes max.

Table 11: Reflow soldering profile A1029-A/-C

As results of soldering may vary among different soldering systems and types of solder and depend on additional factors like density and types of components on board, the values above should be considered as a starting point for further optimization.

9 Use of Antenna

9.1 Connection of RF Signal

This chapter affects the GPS receiver module A1029-A/-C only.

The ANT pin is used to connect the receiver with the GPS antenna. The design of the antenna connection has to be done strictly according to RF design rules. A 50Ω PCB strip line is required. The following drawings shall explain the guidelines. A major rule is to keep the strip line as short as possible. Additionally, antenna ground (GNDANT) should be routed to the ground plane of the PCB (the ground plane is on a lower PCB layer) by vias as demonstrated in the drawing.

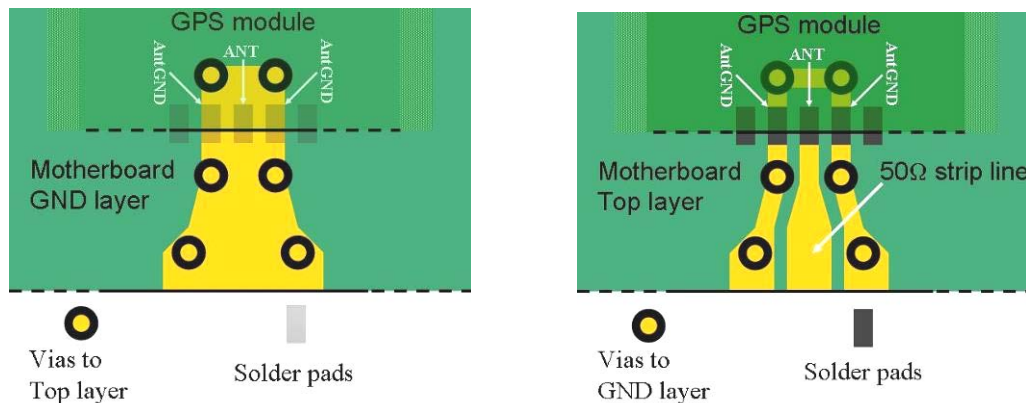


Figure 16: Antenna connector strip line A1029-A/-C

In order to gain the impedance of 50Ω, the width (W) of the strip line needs to be calculated. It depends on the thickness or height (H) of the PCB layer (both parameters are shown in following drawing). For our calculation, we assume that the PCB material is FR4 which typically has an ϵ_R of 4.2 to 5.2.

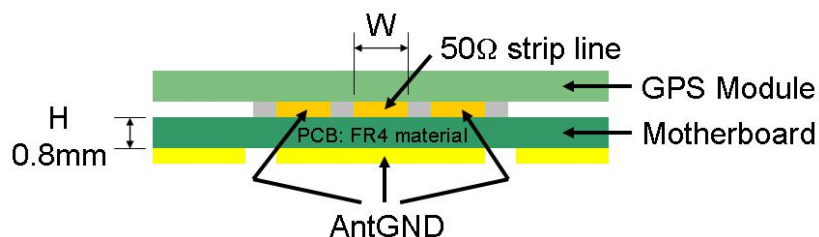


Figure 17: Strip line parameters A1029-A/-C

As a rule of thumb, the width should be about 1.8 times the height of the PCB:

$$W = 1.8 \times H$$

In our example, we would get a width of $W = 1.8 \times 0.8\text{mm} = 1.44\text{mm}$.

9.2 Active Antenna

General GPS active antenna specification:

Limitations:

- Supply voltage according to voltage fed into VANT pin (5V max.)
- Supply current 50mA (max.)

Recommendations:

- Gain $\geq 20\text{dB}$ (should not exceed 35dB)
- Noise figure $\leq 1.5\text{dB}$

The recommendations apply to the majority of active antennas that can be found in the market. Anyhow, the quality of the GPS antenna chosen is of paramount importance for the overall sensitivity of the GPS system.

The system design needs to reflect the supply voltage of the antenna. If the supply voltage is equal to V_{cc} , V_{cc} can be connected to VANT. If the antenna requires a different supply voltage, the antenna bias can be provided through the VANT pin.

9.3 Passive Antenna

Note: Different passive antenna set-ups have been tested with positive results on the performance of the A1029 modules. Anyhow, it is the responsibility of the system integrator to qualify the final configuration.

Please consider that it is crucial to keep the connection from the antenna to the ANT pin as short as possible. Each bit of attenuation between the passive antenna and the ANT pin will degrade GPS performance.

Recommendations:

- Antenna gain: $>2\text{dBi}$
- Antenna gain: $< 2\text{dBi}$ / LNA close to the antenna recommended!

Please make sure that the antenna is properly tuned to its dielectric environment.

10 Quality and Reliability

10.1 Environmental Conditions

Operating temperature	-40 ... +85°C
Operating humidity	Max. 85% r. H., non-condensing, at 85°C
MSL JEDEC (Moisture Sensitivity Level)	3
Storage	6 months in original package.

Table 12: Environmental conditions

10.2 Product Qualification

Prior to product qualification the GPS receiver is preconditioned according to EIA/JEDEC standard JESD22-A113-B / Level 3.

Basic qualification tests:

- Reflow simulation on test PCB (A1029-A/-C only)
- Temperature Cycling –40°C ... +85°C
- Temperature Humidity Bias 85°C / 85% RH
- High / Low Temperature Operating –40° / +85°C
- High Temperature Operating Life +85°C
- Vibration Variable Frequency
- Mechanical Shock

Please contact Tyco Electronics for detailed information.

10.3 Production Test

Each module is electrically tested prior to packing and shipping to ensure state of the art GPS receiver performance and accuracy.

11 Applications and Hints

11.1 Minimum Configuration

Please refer to chapter 3.1 Minimum Configuration for details. In addition, for optimized start-up behavior it is strongly recommended to add a battery back-up circuit (see chapter 3.4)!

11.2 Antenna Sensor Pin (ANTSTAT)

The Antenna Sensor pin is an output pin. It provides correct status information for an active GPS antenna with current consumption in the defined range! For an active antenna with a current consumption outside this range, an external circuit could detect the connection or a disconnection or a short circuit.

- Logic low when: $I_{ant} < 9\text{mA}$
- Logic high when: $9\text{mA} > I_{ant} < 16\text{mA}$
- Logic low when: $I_{ant} > 16\text{mA}$

The threshold values are typical values. Values in an application can defer towards a wider range.

I_{ant} = DC current of GPS antenna (DC current through sensing resistor on GPS module)

The Antenna Sensor pin can detect when an active antenna is connected. It can also detect when the antenna is short-circuited or disconnected for some reason.

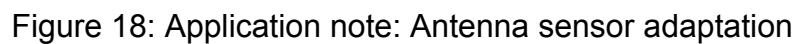
Please consider that the Antenna Sensor can provide no useful output when the GPS antenna is fed externally, i.e. the VANT pin is not used (the sensing resistor on the GPS module can not sense any DC current).

11.2.1 Antenna Status Adaptation

11.2.1.1 Antennas with Different Current Draw

The following circuit is a proposal on how you can feed an antenna with 3.3V and provide an output for the ANTSTAT pin that is adapted to the range the ANTSTAT pin detects as the valid one if and when the antenna is working properly. The value of the components may need an adaptation in the final application. For example, the input current of the chosen comparator goes into that equation. The thresholds defined in this circuit are quite close to the ones of the ANTSTAT detection thresholds. Their value is determined by resistors R4, R5, and R3.

We strongly recommend simulating and testing your realized version before using it. In any case, it is the responsibility of the designer to test and verify the implementation.



This proposal is similar to the first one, but includes a current limiter. Comments and notes as above apply.

Common node on PCB

U1, U2: rail-to-rail single supply comparator with open drain output

VCC33

R6 100R

R1 12R

R4 2.2k

R5 2.2k

R3 63.4k

R2 100k

R7 10k

BC858C Q2

BC858C Q1

U1 LMV7275

U2 LMV7275

VANT

ANTSTAT

GND

Output:

- * open drain with pullup (R2)
- * High for $9\text{mA} < I_{\text{ant}} < 18\text{mA}$
- * Low for $I_{\text{ant}} < 9\text{mA}$ or $I_{\text{ant}} > 18\text{mA}$

Figure 19: Application note: Antenna sensor adaptation with current limiter

11.3 Gain select pin (GS)

The LNA Gain Select pin is an input pin.

- Pin at GND (low) or open: LNA Gain 14dB (default)
- Pin at Vcc (high): LNA Gain 4dB

It is recommended to leave the pin unconnected. This allows for amplification of weaker signals and a firmware implementation of an automatic gain control (AGC) function.

11.4 VANT Pin (antenna voltage input pin)

The VANT pin is an input pin.

The supply voltage for an active GPS antenna has to be fed into the Vant pin. The easiest way to do that is to connect Vcc to VANT. The maximum current is 50mA.

Note: Shortcut between ANT and GND may damage the A1029 GPS receiver module. This should be avoided by using an antenna current limiter.

Please find proposal for simple current limiter below. If other transistors are used, other resistor values may be necessary as well. We strongly recommend simulating and testing your realized version before using it.

The little schematics below work for Vcc from 3V to 5V. The antenna current will be limited to around 50mA.

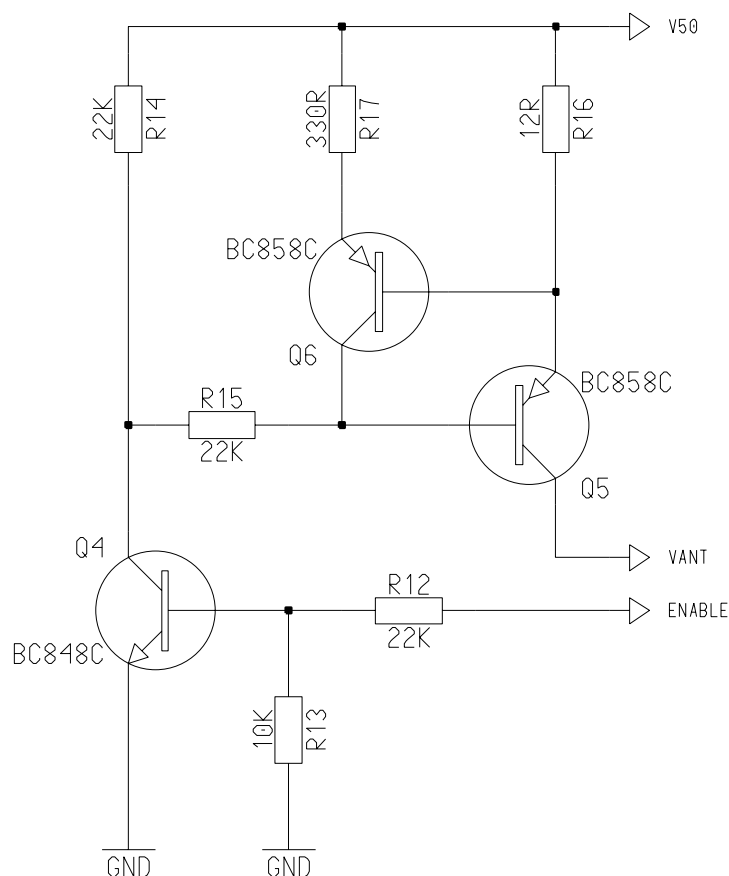


Figure 20: Application note: Antenna current limiter

11.5 LOCK Pin (position fix pin)

The LOCK pin is an output pin.

When there is no valid position fix, the signal on the pin will be a continuous logic low. During a valid position fix phase, the output signal will be a continuous logic high.

11.6 ENABLE Pin (low-power mode)

The ENABLE pin is an input pin.

For enabling normal operation of the module, the pin has to be on HIGH level (e.g. connected to Vcc). When the ENABLE pin is pulled down to GND, the module will go to a low power mode where only the RTC will be supported (if a power source is still connected to Vcc). I.e. date and time will be valid after wake-up. The current draw will fall from typically 50mA to typically 30 μ A. Do not pull down low nRST at the same time! This is not necessary and will result in additional current draw!

11.7 1PPS pin (1 pulse per second pin)

The 1PPS pin is an output pin.

In addition to precise positioning, GPS also allows for accurate timing due to the synchronized atomic clocks in the GPS satellites. While the current date and time is transmitted in NMEA sentences, an exact and accurate timing signal is provided via the 1PPS pin of the A1029 modules.

The 1PPS signal is valid only, whenever the GPS modules provide a valid position fix. Therefore it is recommended to monitor the LOCK signal in parallel (or logically AND the 1PPS and LOCK signals).

The rising edge of the signal is synchronized to GPS time and therefore also to UTC. The 1PPS signal is characterized (a) by the delay “d” between the start of a GPS second and the rising edge of the 1PPS and (b) by standard deviation of this delay providing a measure for the stability or jitter of this signal. Additionally, the duration “l” of the signal is outlined.

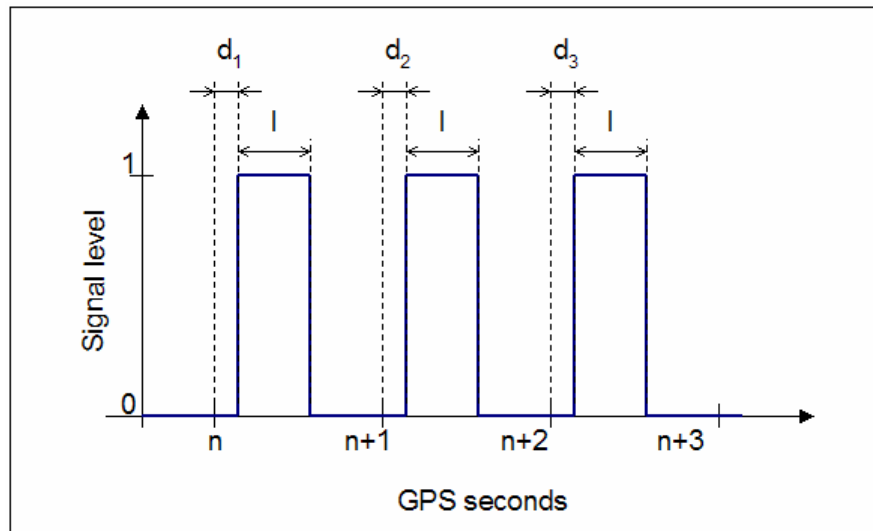


Figure 21: 1PPS signal description

Signal delay d (typical)	130ns
Standard deviation σ_d (typical)	20ns
Signal duration l (typical)	500ms

Table 13: 1PPS signal characterization with active antenna with filter at 22°C

Signal delay d (typical)	90ns
Standard deviation σ_d (typical)	20ns
Signal duration l (typical)	500ms

Table 14: 1PPS signal characterization with passive antenna at 22°C

The standard deviation is a probability measure for the occurrence of value within a certain range. 68.3% of all new values will be within 1σ of the expected value, 95.5% within 2σ .

11.8 Reset Signal

The nRST pin is an input pin.

The nRST pin can be used to generate a reset on the A1029 modules. Resetting the module will result in a restart of the complete firmware including the boot loader. All information stored in flash memory will still be valid. The RTC will keep on running. The same result can be achieved using the ENABLE pin. Therefore connecting nRST is usually not necessary.

Note: In case of low power mode (ENABLE pin low) DO NOT pull nRST to low. This will result in additional current draw.

In case the rise time of the supply voltage signal from 0V to the minimum Vcc threshold is longer than 10ms, it is recommended to implement an external reset controller. This reset controller will keep the nRST at low level as long as the controller's threshold is not reached.

The proposal below is based on the reset controller MAX809STRG from ON Semiconductor with a threshold of 2.93V. Other controllers could be used as well. Anyhow, it is the responsibility of the designer to test and verify the implementation.

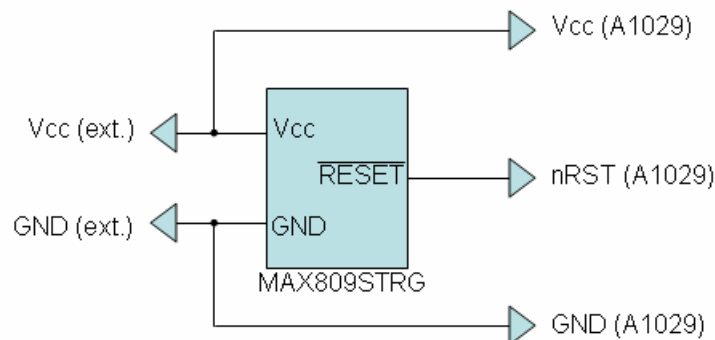


Figure 22: Application note: External reset controller

11.9 Battery Back-up

This application note describes an example on how to back-up the RTC of the GPS receiver modules. The note applies to the A1029-C and A1029-D in the same way. V_{MAIN} is considered to be 3.3V (3.0V to 3.6V) and V_{BAT} in the range of about 2.2V to 3.6V. 3.6V is the absolute maximum rating for the voltage supplied to the module and must not be exceeded!

The circuits below are – although realized and tested – examples only. It is the responsibility of the designer to test and verify the implementation.

11.9.1 Simple Example

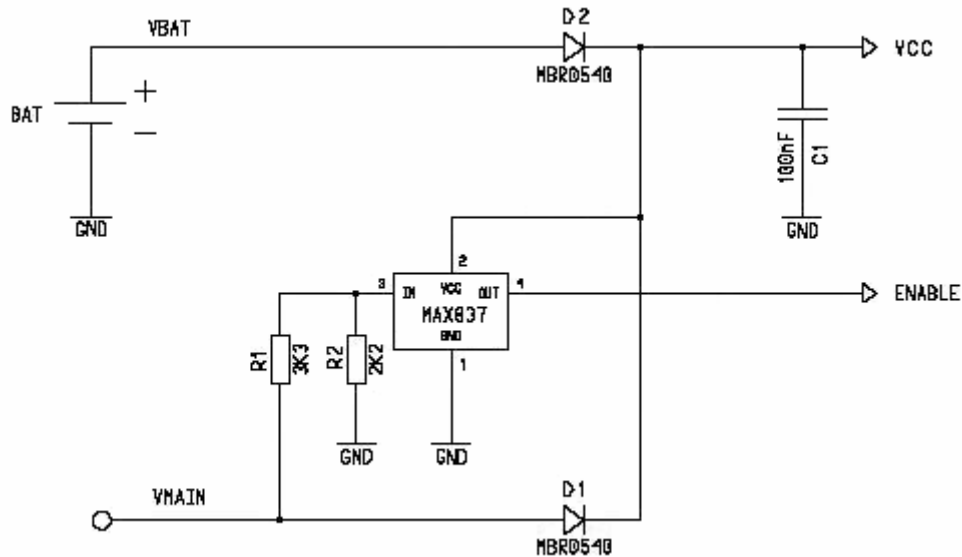


Figure 23: Application note: Battery back-up semi-discrete solution

Note: The capacitor C1 is a switch over capacitor to protect the module.

The battery back-up circuit has to fulfill two tasks:

- Control the ENABLE input
- Provide power to VCC

The ENABLE control part is build up around the Maxim MAX837 voltage monitor. The MAX837 will switch the ENABLE signal to low, whenever V_{MAIN} falls below a certain threshold (1.204V according to the MAX837 datasheet). V_{MAIN} is divided by R1 and R2 (3.3k and 2.2k, respectively). The input voltage will therefore be $\frac{2}{5} * V_{MAIN}$. This means that the threshold will be reached, whenever V_{MAIN} falls below 3.01V! Above this threshold, ENABLE will be high and the module will work in normal operation mode.

The power for the module is provided via the two diodes D1 and D2. The module will draw current from the source with the higher potential. E.g. if V_{MAIN} is at 3.6V and the battery voltage is at 3.0V, Vcc will be provided from V_{MAIN} .

Obviously, this solution shows some weaknesses. First of all, the module will draw current from V_{BAT} whenever V_{BAT} is higher than V_{MAIN} – even if V_{MAIN} would still be sufficient. This will result in draining the battery until the potential of V_{MAIN} is reached. Secondly, the current draw on D1 will add to the power consumption of the system.

In order to overcome these weaknesses, a more sophisticated solution is described in the following paragraph.

11.9.2 Integrated solution

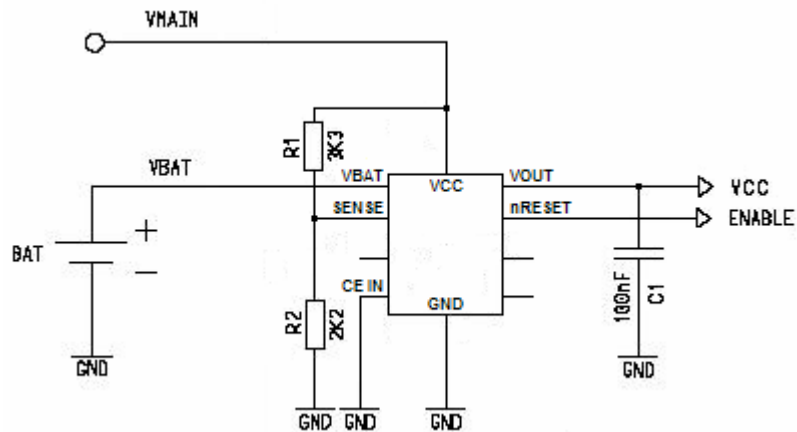


Figure 24: Application note: Battery back-up integrated solution

This circuit uses the Texas Instruments battery back-up supervisor TPS3613-01. In fact, only a part of the complete functionality of the IC is needed to fulfill the two tasks described above.

The control of the ENABLE signal is done in the very same way than described above – as long as V_{MAIN} stays above a defined threshold. The provision of power to the module (Vcc) is done by V_{MAIN} – again as long as V_{MAIN} stays above this threshold. This way we avoid using V_{BAT} even if V_{MAIN} is still sufficient. In addition, the additional power consumption can be neglected!

In our example we chose R1 to be 3.3k and R2 to be 2.2k resulting in a voltage at the SENSE input at $\frac{2}{5} * V_{MAIN}$. The threshold for the SENSE input is 1.15V, i.e. nRESET will go to low, whenever V_{MAIN} falls below 2.875V. This voltage should still be above the battery voltage supplied in your application.

12 Demonstration Kits

12.1 USB Kit A1029-A/-C

For demonstration and easy evaluation of GPS performance Tyco Electronics offers a Demonstration Kit (including one GPS A1029-A/-C module). It contains a USB interface with according drivers to connect easily to a PC. The USB interface is an extension of the serial port 0, therefore sending NMEA sentences and accepting commands. At the same time it provides power to the module. Accompanied by an antenna it offers a ready-to-go set. For further information please contact Tyco Electronics.



Figure 25: Demonstration kit USB1029-A/-C

12.2 Evaluation Kit A1029-A/-C

For the development of new software and applications an Evaluation Kit is available. It shows various connectors for easy access to the JTAG port, to the general purpose I/Os, and the serial ports. It can be powered by battery or externally. For further information please contact Tyco Electronics.

12.3 Demonstration Kit A1029-B/-D

For demonstration and easy evaluation of GPS performance Tyco Electronics offers a Demonstration Kit (including one GPS A1029-B/-D module). It shows two serial interfaces (NMEA and RTCM). The Demonstration Kit can be powered by an external 5 to 12V source. Accompanied by an antenna and serial cable it offers a ready-to-go set. For further information please contact Tyco Electronics.

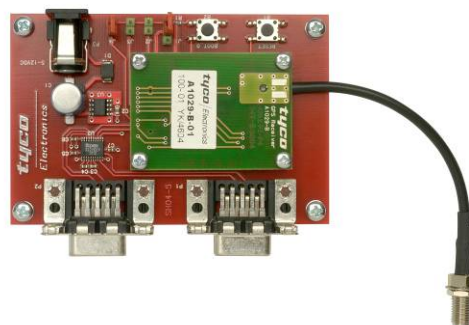


Figure 26: Demonstration kit DKS1029-B/-D

13 Related Information

13.1 Contact

This manual was created with due diligence. We hope that it will be helpful to the user to get the most out of the GPS module.

Anyway, inputs about errors or mistakable verbalizations and comments or proposals to TYCO Electronics, Power Systems in Munich, Germany, for further improvements are highly appreciated.

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sales.gps@tycoelectronics.com.

13.2 Related Documents

- Manual: T.E. GPS Firmware A1029 (TYCO)
- Manual: T.E. GPS Firmware DR A1029 (TYCO)
- Manual: T.E. GPS DemoKit USB1029 (TYCO)
- Manual: T.E. GPS EvaluationKit EVA1029 (TYCO)
- Manual: T.E. GPS DemoKit DKS1029 (TYCO)

14 List of Tables

Table 1: A1029 characteristics.....	8
Table 2 and 3: A1029-A/-C and A1029-B/-D dimensions and weight.....	8
Table 4: Additional equipment.....	12
Table 5: Pin description A1029-A/-C (part 1)	20
Table 6: Pin description A1029-A/-C (part 2)	21
Table 7: Pin description A1029-B/-D (part 1 – odd pin row)	23
Table 8: Pin description A1029-B/-D (part 2 – even pin row)	23
Table 9: Operating Conditions	30
Table 10: Absolute maximum ratings.....	30
Table 11: Reflow soldering profile A1029-A/-C	32
Table 12: Environmental conditions	35
Table 13: 1PPS signal characterization with active antenna with filter at 22°C	41
Table 14: 1PPS signal characterization with passive antenna at 22°C	41

15 List of Figures

Figure 1: A1029 label	7
Figure 2: A1029-A/-C tape specifications (1)	10
Figure 3: A1029-A/-C tape specifications (2)	11
Figure 4: A1029-B/-D tray specification.....	11
Figure 5: Recommended minimum configuration A1029-A/-C	13
Figure 6: Mechanical outline overview A1029-A/-C	15
Figure 7: Mechanical outline component side A1029-A/-C	16
Figure 8: Mechanical outline solder side A1029-A/-C	17
Figure 9: Mechanical outline overview A1029-B/-D	18
Figure 10: Pin-out information A1029-A/-C (top view).....	19
Figure 11: Pin out information A1029-B/-D (bottom and top view)	22
Figure 12: Connecting an odometer signal	25
Figure 13: Connecting the gyro Melexis MLX90609-N.....	26
Figure 14: Power supply for internal ADC (Vcc3A)	28
Figure 15: Soldering footprint proposal A1029-A/-C	31
Figure 16: Antenna connector strip line A1029-A/-C	33
Figure 17: Strip line parameters A1029-A/-C	33
Figure 18: Application note: Antenna sensor adaptation.....	37
Figure 19: Application note: Antenna sensor adaptation with current limiter.....	37
Figure 20: Application note: Antenna current limiter	39
Figure 21: 1PPS signal description	41
Figure 22: Application note: External reset controller.....	42
Figure 23: Application note: Battery back-up semi-discrete solution	43
Figure 24: Application note: Battery back-up integrated solution	44
Figure 25: Demonstration kit USB1029-A/-C	45
Figure 26: Demonstration kit DKS1029-B/-D	45