The right one.™

COPERNICUS II
GPS RECEIVER MODULE

TECHNICAL HIGHLIGHTS

Receiver: GPS L1 frequency (1575.42 MHz), C/A code, 12-channel continuous tracking

–160 dBm tracking sensitivity

132 mW typical continuous tracking

Fast TTFF (cold start 38 sec)

NMEA, TSIP and TAIP protocols

2 serial ports

On-board low noise amplifier

Use with passive or active antennas

OPEN and SHORT pins for external antenna circuit protection

Supports SBAS (WAAS, EGNOS, MSAS)

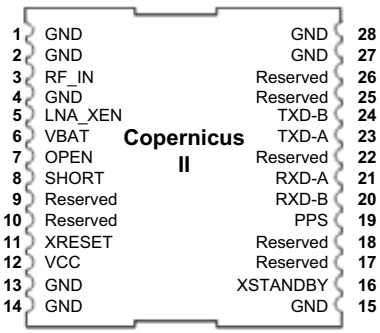
aGPS capable

Update rate of 1 Hz

PPS timing output

28 surface mount castellations

Available mounted on a carrier board or in a starter kit



Pin Out Diagram

GENERAL OVERVIEW

Trimble's Copernicus II GPS receiver module provides the sensitivity and speed demanded by poor signal conditions. With its small size and low power requirements, it is perfect for portable, handheld, battery-powered applications, as well as vehicle tracking, navigation, and security uses.

The Copernicus II receiver features powerful positioning performance in a 19.0 mm x 19.0 mm x 2.54 mm package. The module's 28 reflow-solderable surface-mount edge castellations provide an interface for your design without the need for costly connectors.

The module provides an L1 Frequency GPS receiver, with TSIP and NMEA protocols from two serial ports. The TAIP protocol is also supported. The module includes an onboard RTC and TCXO, and provides a PPS timing output.

Pin 1 location

Copernicus II

The Copernicus II has an onboard low noise amplifier (LNA) that is compatible with both active and passive antenna implementations. It has pins for external antenna detection for open and short circuit conditions.

The Copernicus II [P/N 63530-00] is available mounted on a carrier board [P/N 63531-00] or in a complete starter kit for quick testing and integration [P/N 63532-05].

PIN OUT TABLE

PIN#	FUNCTION	I/O	DESCRIPTION
1-2	GND		Ground.
3	RF_IN	Input	GPS signal input 50 Ω unbalanced (coaxial) RF input.
4	GND		Ground.
5	LNA_XEN	Output	LNA External Enable, used with active antennas only.
6	VBAT	Input	Optional backup power 2.7 V to 3.3 V.
7	OPEN	Input	Logic level from external antenna detection circuit.
8	SHORT	Input/Output	Logic level from (and to) external antenna detection circuit.
9–10	Reserved		Do not connect.
11	XRESET	Input	Active low logic level reset. Do not connect if not used.
12	VCC	Power	Module power supply 2.7 V to 3.3 V.
13-15	GND		Ground.
16	XSTANDBY	Input	Selects "Run" or "Standby" mode. Connect to VCC if not used.
17–18	Reserved		Do not connect.
19	PPS	Output	Logic level timing signal at 1 Hz. Do not connect if not used.
20	RXD-B	Input	Logic level secondary serial port receive.
21	RXD-A	Input	Logic level primary serial port receive. Pull high if not used.
22	Reserved		Do not connect.
23	TXD-A	Output	Logic level primary serial port transmit.
24	TXD-B	Ouput	Logic level secondary serial port transmit.
25–26	Reserved		Do not connect.
27–28	GND		Ground.

Trimble®

GPS PERFORMANCE SPECIFICATIONS

GPS performance statistics are clear view, stationary. Sensitivity based on signals measured at the antenna.

PARAMETER	VALUE(S)
Update Rate	1 Hz
Number of Channels	12
Accuracy	
Position (autonomous)	<2.5 m 50%, <5 m 90%
Position (SBAS)	<2 m 50%, <4 m 90%
Altitude (autonomous)	<5 m 50%, <8 m 90%
Altitude (SBAS)	<3 m 50%, <5 m 90%
Static PPS	±60 ns RMS
Velocity	0.06 m/s
PPS, Stationary Mode "Indoor"	±350 ns @ -145 dBm
Acquistion time	
Re-Acquisition	2 s 50%
Hot Start	3 s 50%
Hot Start - No battery backup[1]	8 s 50%
Warm Start	35 s 50%
Cold Start	38 s 50%
Sensitivity	
Tracking	–160 dBm
Acquistion[2]	–148 dBm
Dynamics	
Acceleration	2 g
Max Operational Velocity	515 m/s

1. Ephemeris not older than 4 hours.
2. –148 dBm for hot start with up-to-date ephemeris in High Sensitivity Mode; –144 dBm for otherwise in High Sensitivity Mode; –142 dBm in Standard Sensitivity Mode.

GPS COMMUNICATION PARAMETERS

GPS output is available from two serial interfaces (UART). The output adheres to the TSIP and NMEA 0183 protocols (for ports A and B respectively) by default.

- Trimble's powerful TSIP protocol (Trimble Standard Interface Protocol) provides detailed satellite information and offers complete control over receiver operation.
- The bi-directional NMEA 0183 protocol offers industry-standard data messages for easy interface to mapping software. There is also a set of proprietary command messages.
- The TAIP protocol (Trimble ASCII Interface Protocol) is an easy-to-use ASCII protocol designed specifically for track-and-trace applications.

The Copernicus II output for the three protocols has the following characteristics.

GPS Output Characteristics

PARAMETER	TSIP	NMEA 0183	TAIP
Default Serial Port	A	B	–
Default Baud Rate	38400	4800	4800
Available Baud Rates	4800 9600 19200 38400 57600 115200	4800 9600 19200 38400 57600 115200	4800 9600 19200 38400 57600 115200
Message Output Rate	1 Hz	1 Hz	1 Hz

Port B Serial Communication

Note the following to avoid problems with missing or mistimed NMEA messages.

How does Port B affect Port A? Every second, GPS data comes out on Port A first, then on Port B. If Port B generates a lot of serial traffic and takes up a significant amount of time, Port A will not send out data on time during the following second.

For example, if the Trimble GPS Studio application is used with AUTO-QUERY ON at a 4800 baud rate on Port B, this will overload the unit. To run the Trimble GPS Studio application on Port B with minimum impact, change the baud rate appropriately. A count of the bytes sent will determine which baud rates will work correctly.

If Port B is not used, turn it off completely with this TSIP 0xBC Protocol Configuration command:

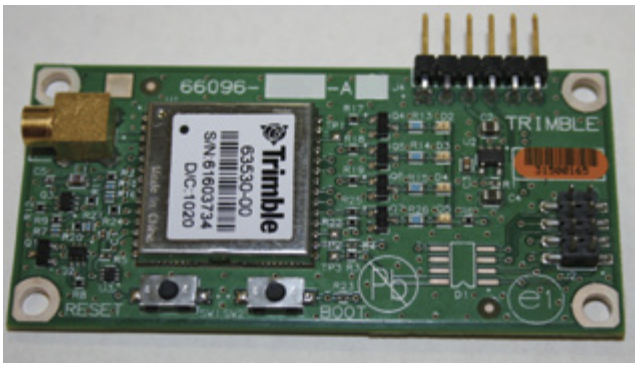
10 BC 01 06 06 03 00 00 00 00 00 00 10 03

GPS COMMUNICATION PACKETS / MESSAGES

TSIP - Key Automatic Output Packets[1]

PACKET ID	DESCRIPTION
0x41	GPS time
0x42, 0x83, 0x4A, 0x84, 0x8F-20	Position (choose packet with I/O options)
0x43, 0x56, 0x8F-20	Velocity (choose packet with I/O options)
0x46	Health of receiver
0x48	Machine code/status (includes antenna fault detect)
0x6D	All-in-view satellite selection, DOPs, fix mode
0x82	SBAS fix mode (always the last packet of the fix information)

1. Other packets can also be automatically output, but this table lists the ones that provide the information most commonly used. For minimal system implementations, these provide all the information required for operation. No input packets are required.



Copernicus II Reference Board 63531-00

NMEA 0183 Messages

MESSAGE	DEFAULT	DESCRIPTION
GGA	Default	GPS fix data
VTG	Default	Track Made Good and Ground Speed
GLL	Other	Geographic position – Latitude/Longitude
GSA	Other	GPS DOP and active satellites
GST	Other	GPS accuracy information
GSV	Other	GPS satellites in view[1]
RMC	Other	Recommended minimum specific GPS/Transit data
ZDA	Other	Time and date

1. GSV message requires at least a 9600 baud rate.

TAIP Messages

MESSAGE	DESCRIPTION
AL	Altitude/Up Velocity
CP	Compact Position Solution
ID	Identification Number
IP	Initial Position
LN	Long Navigational Message
PR	Protocol
PT	Port Characteristic
PV	Position/Velocity Solution
RM	Reporting Mode
RT	Reset Mode
ST	Status
TM	Time/Date
VR	Version Number

ELECTRICAL SPECIFICATIONS

PARAMETER	VALUE(S)
Serial Interfaces – UART	1 TSIP, 1 bidirectional NMEA
Level	3.0 V CMOS, TTL compatible
PPS Interface	1 Hz timing pulse, output
Level	3.0 V CMOS, TTL compatible
PPS Accuracy to UTC	±60 ns RMS
Pulse Width	4.2 µs default (configurable)
OPEN / SHORT I/O	Logic levels for open and short detection
Level	3.0 V, TTL compatible
GPS Input RF Interface	GPS signal input 50 Ω unbalanced (coaxial) RF input
Main Power Supply	
V_{CC} DC Levels	2.7 V to 3.3 V; 3.0 V typ
Consumption (current)	44 mA (132 mW) typ
RTC and Backup Power Supply	
VBAT DC Levels	2.7 V to 3.3 V
Consumption (current)	7 µA typ @ +25°C

ENVIRONMENTAL SPECIFICATIONS

PARAMETER	VALUE(S)
Temperature	
Operating	–40 °C to +85°C
Storage	–55 °C to +105°C
Humidity	5% to 95% non-condensing @ 60°C
Vibration	
5 Hz to 20 Hz	0.008 g^2/Hz
20 Hz to 100 Hz	0.05 g^2/Hz
100 Hz to 900 Hz	–3 dB/octave

PHYSICAL SPECIFICATIONS

PARAMETER	VALUE(S)
Dimensions	19.0 mm x 19.0 mm x 2.54 mm
Weight	1.724 g including metal shield

ABSOLUTE MAXIMUM RATINGS

CAUTION–Absolute maximum ratings indicate conditions beyond which permanent damage to the device may occur. Electrical specifications do not apply when operating the device outside its recommended operating conditions.

PARAMETER		MIN	MAX	UNIT
Main power supply voltage	(V_{CC})	–0.3	3.6	V
VBAT power supply voltage	(V_{RTC})	–0.3	3.6	V
Antenna input power at RF input	(dBm)		+10 max	dBm
Storage temperature	(T_s)	–55	+105	°C

RECOMMENDED CONDITIONS OF OPERATION

PARAMETER		MIN	MAX	UNIT
Primary power supply voltage[1]	(V_{CC})	2.7	3.3	V
Battery power supply voltage	(V_{BAT})	2.7	3.3	V
Input pin threshold voltage (RXD-A, RXD-B, OPEN, SHORT, XSTANDBY)				
with Status = High	(V_{IH})	2.0	V_{CC}	V
with Status = Low	(V_{IL})	0	0.8	V
Input pin threshold voltage (XRESET)				
with Status = High	(V_{IH})	2.0	V_{CC}	V
with Status = Low	(V_{IL})	0	0.1	V
Output pin threshold voltage (TXD-A, TXD-B, LNA_XEN)				
with Status = High (I_{OH} = 1 mA)	(V_{OH})	0.8 * V_{CC}	V_{CC}	V
with Status = Low (I_{OL} = 1 mA)	(V_{OL})	0	0.2 * V_{CC}	V
Hardware XRESET (assert XRESET pin)	(XRESET)	100		µs
Ambient operating temperature	(T_A)	–40	+85	°C

1. See Supply Voltage Requirement below.

ELECTRICAL CHARACTERISTICS

Characteristics apply to corresponding operating conditions as stated, with typical @25 °C.
Measurements are made over temperature range –40 °C to +85 °C.
Measured results are typical and do not guarantee performance.

PARAMETER	MIN	TYP	MAX	UNIT
Current Draw, continuous tracking (excluding antenna supply)		44	60	mA
Power Consumption, continuous tracking (excluding antenna supply)		132	180	mW
Current Draw, standby mode (VBAT pin only; V_{BAT} = 2.96)		7		µA
Current Draw, standby mode using serial command (VCC and VBAT pins)		12		µA
Supply Ripple Noise, 1 Hz to 1 MHz			50	mVpp
Supply Ripple Noise, GPS TCXO freq 16.368 MHz ± 5 kHz			1	mVpp
External LNA noise figure			2	dB

SUPPLY VOLTAGE REQUIREMENT

The Primary Supply Voltage (V_{CC}) slope from 0 V to V_{CC} must have a rise time that is greater than 140 µs.

PIN DESCRIPTIONS

Antenna Input RF_IN (Pin 3)

The RF input pin is the 50 Ω unbalanced GPS RF input, and can be used with active or passive antennas.

LNA_XEN (Pin 5)

Use this logic level output to control power to an external LNA or other circuitry. The logic of this signal is such that when the module is running (that is, not in standby mode), the signal is low. In standby mode, the signal is high. Use this pin to control the gate of a p-channel FET that is used as a switch.

OPEN and SHORT (Pins 7 and 6)

When using an active antenna, Trimble recommends that you implement an antenna detection circuit with short circuit protection. Two pins are provided for reporting the antenna status: OPEN and SHORT.

Use the logic level inputs in ELECTRICAL SPECIFICATIONS with a detection circuit to monitor the status of the external LNA of an active antenna. The pins conform to the Input / Output Pin threshold levels specified in RECOMMENDED CONDITIONS OF OPERATION.

Truth Table for Logic of OPEN and SHORT Pins

ANTENNA REPORTED AS...	SHORT	OPEN
Open	1	1
Normal	1	0
Shorted	0	0
Undefined	0	1

XSTANDBY – Standby Mode Input (Pin 16)

This logic level input is used to control the run/standby state of the module. If this signal is high, the unit runs normally. If it is low, the unit goes to standby mode.

In standby mode, power is maintained either at the VCC or VBAT pin - the Copernicus II GPS receiver's RAM memory is kept alive, and the real-time clock runs while the rest of the receiver is turned off. RAM memory is used to store the GPS almanac, ephemeris, and last position.

Using this information, together with the time information provided by the real-time clock, the receiver normally provides faster startup times. The type of start-up after Standby mode depends on the state of the receiver before entering Standby mode and on the length of time the receiver spent in Standby mode.

The GPS almanac, ephemeris and recent position are automatically stored in non-volatile flash memory. Even without time, the receiver can use the information stored in flash memory to shorten the start-up time. The data automatically stored in flash will be used if the power was removed and data lost from RAM.

Note about User Configuration: The user configuration is also stored in RAM, if the user does not specifically save it to flash (see the Copernicus II User Guide for save commands). This configuration will be lost if both VCC and VBAT are removed and the GPS configuration will return to factory defaults.

Providing the power is maintained to RAM or the user configuration is saved to flash, using either the XSTANDBY or XRESET pins will not delete the user settings.

PPS – Pulse-Per-Second Output (Pin 19)

This logic level output provides a 1 Hz timing signal to external devices. The default pulse width of this signal is 4.2 µs. The pulse width is configurable.

For timing applications, you must capture the time from the timing message for the protocol you are using. For TSIP, report packets 41 and 8F-21 are used. For NMEA, the ZDA message is used. Position messages contain a timestamp that can be 1 to 2 seconds in the past. Therefore, do the following to acquire the correct time:

1. Confirm that the almanac is complete and that the receiver is generating 3D fixes. This eliminates the UTC offset jump.
2. Confirm that the receiver is configured for the late PPS options (that is, it only outputs a PPS on a 3D fix).
3. IF you are using TSIP, capture the time from the TSIP packet 0x41 or TSIP packet 0x8F-20.
4. Once time is acquired, add 1 to the whole second on the next PPS to read the correct time.

Serial Port Default Settings (Pins 20, 21, 23, and 24)

Two serial ports are supported. Protocol and baud rate are user configurable. Data bits, parity and stop bits are not. Flow control is not available.

Serial Port Default Settings

PORT	PORT DIRECTION	PIN#	PROTOCOL	CHARACTERISTICS				
				Default Baud Rate	Data Bits	Parity	Stop Bits	Flow Control
A	TXD-A	23	TSIP out	38400	8	None	1	None
A	RXD-A[1]	21	TSIP in	38400	8	None	1	None
B	TXD-B	24	NMEA out	4800	8	None	1	None
B	RXD-B	20	NMEA in	4800	8	None	1	None

1. If not used, pull high.

XRESET (Pin 11)

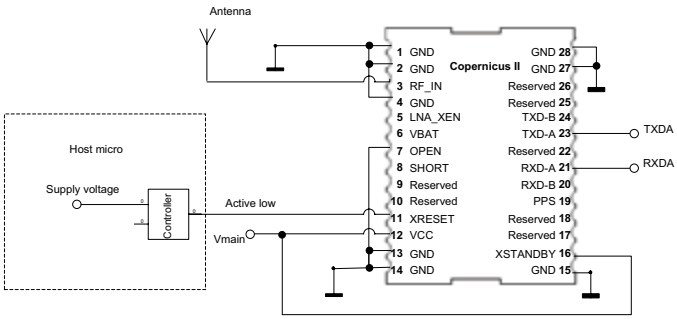
Connects to the host system reset controller or GPIO for host-controlled resetting of the GPS module.

XRESET Circuit Recommendations

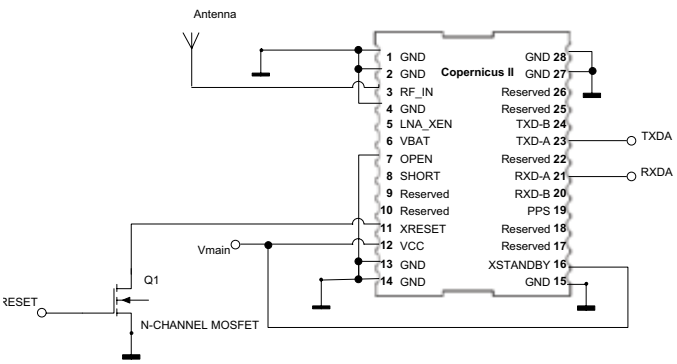
The XRESET pin has to be pulled below 100 mV for at least 10 µs to assure correct reset operation.

The Copernicus II module should be externally reset by a power-on-supervisor or host CPU.

The XRESET pin should be driven actively by an external power-on-reset circuit. It will be compatible with a CMOS totem-pole or open-drain driver.

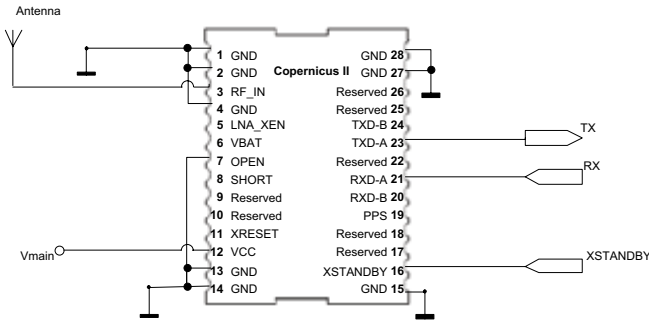


The circuit below shows an example of a FET circuit used to invert a positive RESET signal:



APPLICATION NOTES

Passive Antenna - Hardware Activated Standby Application Circuit for Copernicus II

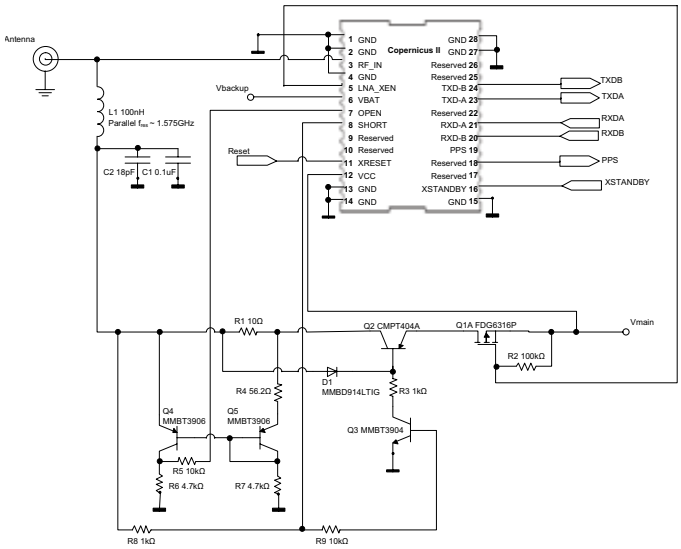


Passive Antenna and Hardware-Activated Standby

Notes for Passive - Standby Antenna Circuit

- A passive antenna is used. The receiver has an on-board LNA and an automatic gain control circuit.
- The pin LNA_XEN is not necessary and not connected.
- There is no hardware reset ability through the pin XRESET.
- Hardware-initiated Standby mode is possible through pin XSTANDBY, since XSTANDBY pin is not tied High to V_{CC}
  The software serial command to Standby mode can alternatively be used as a second method to force the module into Standby mode (63530-10 version only).
- There is no separate second power source being applied for standby voltage.
- Only one serial port is used.
- No Antenna open and short detection/protection is provided. When OPEN (pin 7) and SHORT (pin 8) are kept disconnected (floating), the receiver reports an open antenna condition. If a normal condition is desired, tie OPEN low.
  See the antenna open short truth table on page 5.

Active Antenna - Full Connection Application Circuit



Active Antenna with Full Connection
(Short-Circuit Detection and Battery Backup Power)

Notes for Active - Full Connection Antenna Circuit

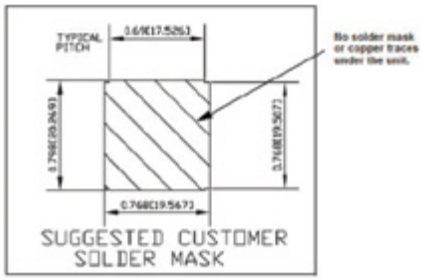
- An active antenna is used.
- Pin LNA_XEN is connected.
- Hardware reset ability is possible through pin XRESET.
- Hardware-initiated Standby mode is possible through pin XSTANDBY, since XSTANDBY pin is not tied High to V_{CC}
- A second power source is applied for the standby voltage.
- Both serial ports are used.
- Antenna open and short detection/protection is provided. The combination of the two pins OPEN (pin 7) and SHORT (pin 8) report the antenna status.
- See the antenna open short truth table on page 5.

SOLDERING INFORMATION

When soldering the Copernicus II module to a PCB, keep an open cavity underneath the Copernicus II module.

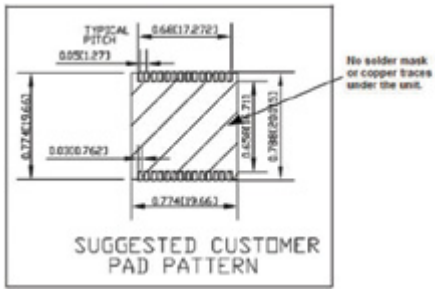
Do not place copper traces or solder mask underneath the module.

Solder Mask



Pad Pattern

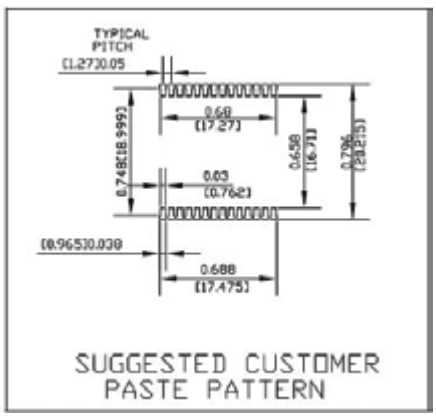
The suggested customer pad pattern is shown below.



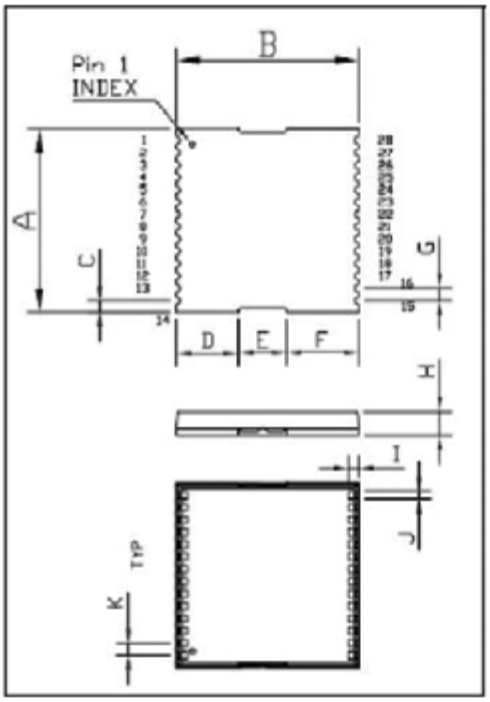
Paste Mask

To ensure good mechanical bonding with sufficient solder to form a castellation solder joint, use a solder mask ratio of 1:1 with the solder pad.

When using a 5 ±1 mil stencil to deposit the solder paste, Trimble recommends a 4 mil toe extension on the stencil.



MECHANICAL OUTLINE DRAWING



Top View

Outline Dimensions (Inch ±0.004 / mm ±0.10)

A	B	C	D	E	F	G	H	I	J	K
0.75	0.75	0.049	0.256	0.197	0.295	0.050	0.100	0.045	0.030	0.050
19.00	19.00	1.25	6.50	5.00	7.50	1.27	2.54	1.14	0.76	1.27

Bottom View

Note: See the *Copernicus II GPS Receiver Reference Manual* for RF Layout Considerations and Soldering Guidelines.

SUPPORT INFORMATION

Get support information, including documentation and support software, at trimble.com:

http://www.trimble.com/embeddedsystems/Copernicus2.aspx?dtID=support

ORDERING INFORMATION

Model	Part #	Feature Differences		Packaging			Reference Board [1] Part #	Starter Kit [2] Part #
		Standby Serial Command Supported	SHORT pin can be pulled HIGH when not used	20-pc tray	100-pc reel	500-pc reel		
Copernicus II	63530-00	No	Yes	√	√	√	63531-00	63532-05
Copernicus II with Soft Shutdown feature supported	63530-10	Yes	Yes	√	√	√		
Copernicus IIA	67415-00	No	No SHORT must be "no connect" if not used	√	√	√		

1. 63531-00 Reference Board includes a 63530-00 module mounted on a carrier board with I/O and RF connectors, including the RF circuitry with the antenna open detection, as well as antenna short detection and protection.
2. 63532-05 Starter Kit includes a 63531-00 Reference Board mounted on interface motherboard in a durable metal enclosure, 3 additional 63530-00 modules, AC/DC power converter, 66800-50 antenna with MCX connector, USB interface cable, and cigarette lighter adapter.

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