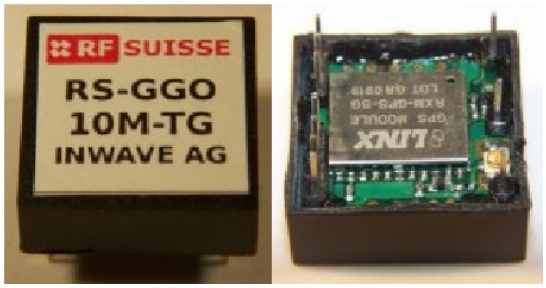
an INWAVE AG brand

RS-GGOxx-TG

GPS Guided Oscillator, TCXO, with GPS receiver

The RS-GGOxx-TG is a reference oscillator with the same form factor as standard OCXO's (1”x1”) but that's all it has in common with them. Instead of drawing a lot of current to heat the crystal it contains a temperature compensated crystal oscillator with 2.5ppm stability which is locked to a 1 Pulse Per Second (1PPS) signal from the integrated GPS receiver. A combination of novel circuits, special firmware algorithms and patented Nano-Technology enable a low current miniature unit with an attractive price. For long term reliability the PCB of the RS-GGOxx-TG is conformal coated with a special Polyisocyanate Prepolymer.
Within less then 2 minutes after GPS lock has been achieved the RS-GGOxx-TG has already reached its specified accuracy of better then 10x10E-9, a value where you have to wait a long time before it's achieved by an OCXO. And at -30C or +80C you may not even get there! Full lock will be achieved after ~15min. Under normal circumstances with average GPS jitter the accuracy will be +/-1ppb. This makes for one of the biggest advantages of the RS-GGOxx-TG, it doesn't have to be powered 24/7 to be stable. Just turn it on a few minutes before you need it and it will provide OCXO stability. Another big advantage of the RS-GGOxx-TG compared to OCXO's is that the crystal doesn't get stressed by heating and cooling which causes the oscillator to never really return to the original frequency.
Forget the search for a Rubidium standard to recalibrate your reference on a regular basis! Hook it up to a GPS antenna and you have the best possible accuracy and stability short of a Rubidium standard.



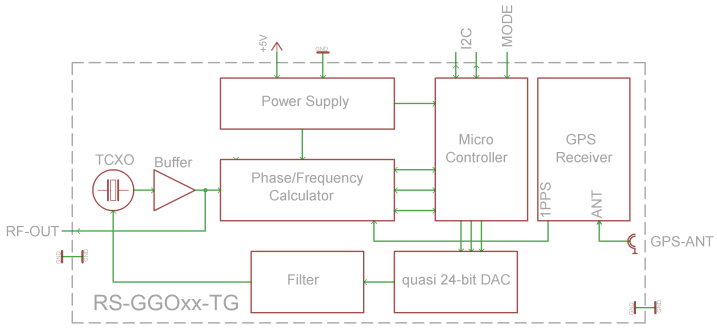
Via a 2-wire interface which operates identical to the well known I²C® the estimated accuracy can be read from the RS-GGOxx-TG. However, programming is only an option but not required for normal operation.
As an alternative the same pins can be used to drive a duo-LED to indicate the internal status (IND = L). Red = no GPS signal, Amber = locking, Green = locked to within spec.

This type of oscillator is commonly called a GPS disciplined oscillator. The word disciplined is misleading as the crystal actually has a better “discipline” or short term stability then the GPS 1PPS signal. The 1PPS signal is only accurate if it is integrated over a larger time frame. During the design of the circuit it was found that just locking

the crystal oscillator to the 1PPS signal with a PLL can lead to undesired offsets (jitter) in frequency which isn't what one expects from a precision reference but what is commonly found in other designs. There is just no good loop bandwidth compromise between responsiveness and speed and suppression of jitter and false or missing pulses. A PLL, no matter whether it is made with PLL ICs or implemented in a DSP, makes for a long time to achieve a precision lock and it will not enable the calculation of the current accuracy and measurement of the GPS jitter. This is why a different locking mechanism with several special algorithms was developed which make sure that the unavoidable and unpredictable jitter of the 1PPS signal will not have a negative effect on the short nor the long term stability of the system. Missing GPS pulses or total failure of the GPS signal will not lead to instant offsets in frequency or immediate loss of accuracy. In its tiny package not only a GSM-grade TCXO but all the electronics and voltage regulators as well as a high performance GPS receiver are installed too!
In short, the GPS signal really guides the TCXO onto the correct frequency which is why we finally settled to call it a GPS Guided Oscillator (GGO).

As excessive peaks of the 1PPS jitter still have impact on the average performance of the system we recommend the usage of a high quality GPS receiver with low jitter specification for the 1PPS signal. The RS-GGOxx-TG, once hooked up to a GPS and within a certain accuracy, will measure the jitter of the GPS and use the results to optimize it's acquisition and control routines. The RS-GGOxx-TG allows the combination of various commercially available GPS “antenna-pucks” with it. However, it has to be stressed that the GPS antenna should be installed with a large unobstructed view of the sky to get the best possible reception!

Block Diagram:



Note: As the GPS control circuit has to improve the stability of the TCXO by a factor of ~2500 even the slightest rapid change in temperature will be able to offset the frequency to the point where the loop has to coarse-capture the signal again leading to “amber LED's”. The RS-GGOxx-TG is insulated as much as possible in its small form factor but it is mandatory to install it in a place where no air circulation occurs and to have additional insulation material on all sides to keep temperature changes below 0.1C/100sec. To further explain this effect imagine that the crystal itself only has a limited thermal coupling to the thermometer and rapid changes of the temperature will take some time before the TCXO temperature compensation circuit will be able to counteract.

The crystal stability itself can be assumed to be in the +/- 20ppm range which means that changes of 0.01C will have significant impact. If these changes are slowed down enough the circuit is able to follow and keep the frequency within the limit where the RS-GGOxx-TG remains within spec and the LED stays steady green.

NOTE: Due to self-heating and voltage ripple caused by the integrated GPS module the achievable stability for the RS-GGOxx-TG is slightly less than what can be achieved with an RS-GGOxx-T and an external GPS receiver.

All RF-SUISSE product comply with RoHS requirements current at the date of delivery.

As we continuously improve our product we reserve the right to change published specifications without further notice. Please see our website at http://www.rf-suisse.ch for current information.

All product manufactured and sold by INWAVE AG under the RF-SUISSE brand is intended for laboratory use or are components (modules) not suitable for consumer use. Thus they are not required to and do not carry CE certification.

Inquiries, quote requests and questions: please email to info@rf-suisse.ch or your INWAVE AG / RF-SUISSE representative. For technical questions please email to tech@rf-suisse.ch

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RS-GGO10-TG

Specifications

Frequency:	standard model RS-GGO10-TG (10MHz)*), wake up with divider setting d1.
	Other frequencies available on request **)
Output:	3.3V CMOS (filtered square wave)
Phase noise (10MHz):	-98 dBc/Hz typ. @ 10Hz offset
	-122 dBc/Hz typ. @ 100Hz offset
	-138 dBc/Hz typ. @ 1KHz offset
	-150 dBc/Hz typ. @ 10KHz offset
	-160 dBc typ. noise floor
1PPS output:	3V CMOS signal. Normally N/C ****)
GPS input:	U.FL type 50 Ohm connector. 3.3V, 35mA max antenna supply.
Power supply:	5VDC +/-10% @ 45mA (65mA peak)
Enclosure:	insulated black ABS plastic, 25x25x10mm (~1x1x0.4") ***)
Temperature range:	-30 to +80C (operating) ***)
Stability:	< 10x10E-9, typical 5x10E-9 = 5ppb (GPS locked)
	+/- 2.5ppm (free running)
Aging:	compensated (GPS locked)
	+/- 1ppm per year (free running)
Interface:	3.3V 2-wire bus with address 72 or 0x48
	(different addresses available for production quantities)
Soldering:	hand or wave soldering only. Max 300C for 5 sec at the tips of the pins.
Marking:	RF-SUISSE, RS-GGO, Frequency-TG, INWAVE AG.
Washing:	not approved!
Weight:	7 g (~0.18oz)

GPS receiver:

Receiver type :	20 Channels; GPS L1 frequency, C/A Code	
Time-To-First-Fix:	Cold Start (Autonomous):	35s
	Hot Start (outdoor):	2s
	Hot Start (indoor):	15s
Sensitivity:	Tracking & Navigation:	-159 dBm
	Cold Start (Autonomous):	-144 dBm
Horizontal position accuracy:	Autonomous:	< 10 m

	SBAS:	< 5 m
Time Pulse:	1Hz, 1µs width positive pulse, 1µs accuracy to GPS time pulse ****)	
Max navigation update rate:	1Hz	
Operational limits:	Altitude 60000ft	
	Velocity 1000 knots	

Required accessories: U.FL antenna cable (not included)

CAUTION: This is an ESD sensitive device!
Proper ESD handling procedures have to be applied to avoid damage.

*) The standard model can be switched to 20, 10, 5, 2.5MHz via the 2-wire interface.
**) The following frequencies can be made available on request for min 25pcs orders (frequency in MHz):
12, 12.8, 14.4, 16, 16.8, 19.2, 19.44, 19.68, 24.576, 26, 33.6, 38.4.
These frequencies can be divided by 1/2/4/8 with a command via the 2-wire interface either permanently or temporary. Phase noise improves 6dB by division of 2 except for noise floor.
***) Changes of the environment temperature have to be kept below 0.1C/100sec!
****) After initial lock the internal GPS receiver does NOT stop the 1PPS pulse when the GPS signal is missing! Without GPS lock this 1PPS signal will drift in frequency.

Maximum Ratings

Supply voltage:	-0.5VDC, 8VDC
2-wire bus, IND:	-0.5 to 3.6V
U.FL:	max 35mA load, no reverse DC.
Storage temperature:	-40 to +90C
Output current:	0.5mA (for LED drive)
ESD protection:	1500V human body model

Programming

There isn't much to the programming. Everything is done via the 2-wire interface. Pull up resistors to 3.3VDC are required! (the 2-wire bus works identical to an I²C® bus)

Commands:

Dx	divide crystal oscillator frequency. Permanent setting. d0= /1, d1= /2, d3= /4, d4= /8
dx	divide crystal oscillator frequency. Temporary setting. D0= /1, D1= /2, D3= /4, D4= /8

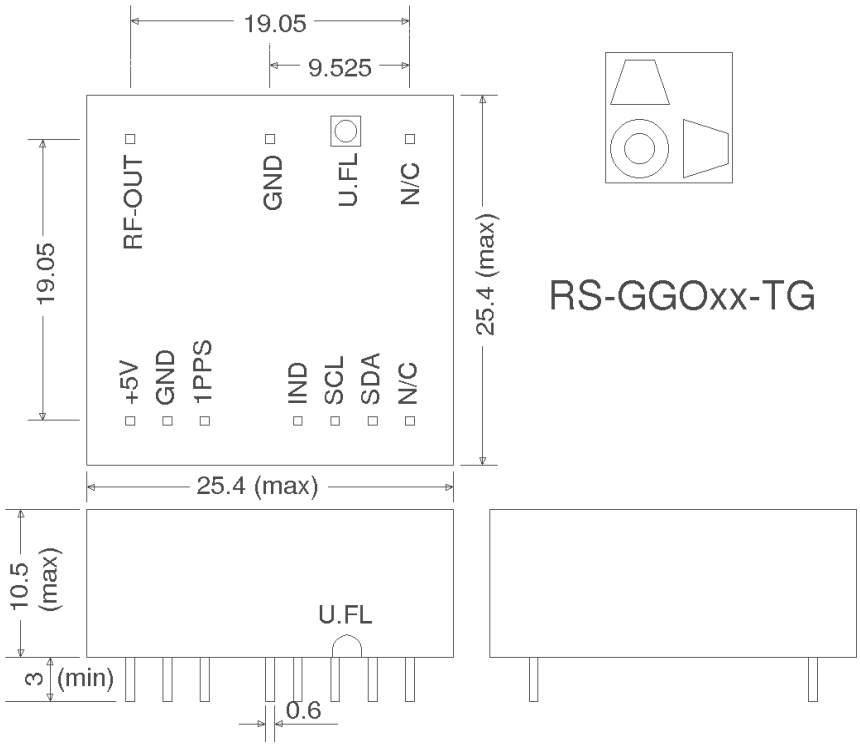
Queries:

QN	read the product name (GGOxx-TG), 16 bytes (xx =10 for RS-GGO10-TG)
QV	read the software revision, 16 bytes (max)
QD	read the date code, 4 bytes
Q#	read the serial number, 4 bytes (binary, little Endian), 32-bit unsigned integer
QG	read the GPS jitter x10E-12, 32-bit single precision floating point little Endian
QF	read frequency error x10E-12, 32-bit single precision floating point little Endian

Remark: DO NOT USE the “DX” command in a controller program to store on a regular schedule as the EEPROM has a guaranteed limit of 100k write cycles only!

Package outline and Pinout

The pin-out fits the industry standard for OCXO's in 1” package with 5 additional pins for the 2-wire bus, 1PPS input, select input and an extra ground pin.

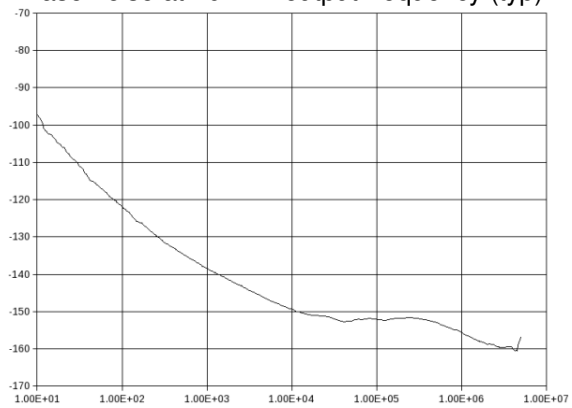


pins are 0.64mm ☐ gold plated, recommended hole diameter is 0.9mm

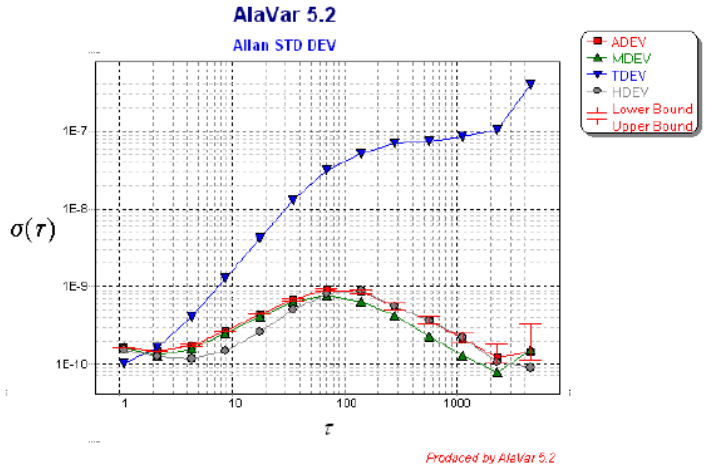
RF-out:	3.3V CMOS filtered, no decoupling capacitor inside, can directly drive 3.3V CMOS logic.
1PPS:	output of GPS-RX 1PPS signal. CMOS 3V, recommended N/C.
SDA, SCL:	(IND = H or open) 3.3V 2-wire bus.
	(IND = L) Duo-LED output (install series resistors of 120R each). SDA = green, SCL = red
IND:	H (3.3V) or open = 2-wire bus, L = Indicator LED
+5V, 2xGND:	stabilized power supply, 4.5 to 5.5VDC, nominal 5VDC
U.FL:	GPS antenna connector, U.FL type, with active antenna supply (3.3V/35mA)
N/C:	Do NOT connect!

Typical performance data for RS-GGO10-TG

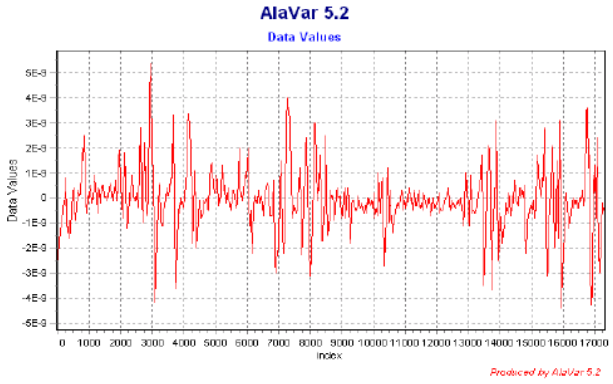
Phase noise at 10MHz output frequency (typ):

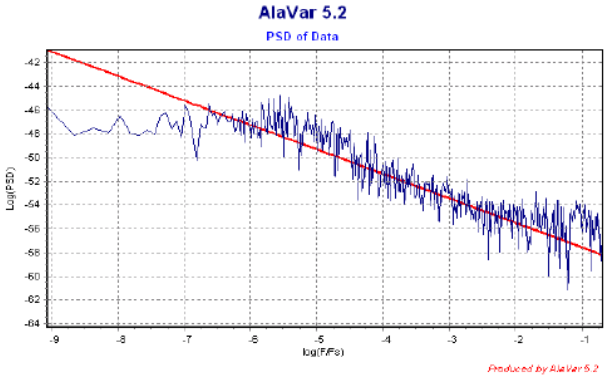


Allan Variance, GPS locked ("normal" GPS reception):



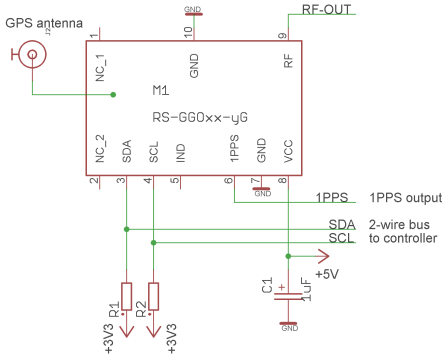
Tau = average Time
ADEV = Overlapping ALLAN STD DEV.
ADEV_Min = ADEV lower bound.
ADEV_Max = ADEV upper bound.
MDEV = Modified ALLAN STD DEV.
TDEV = Time ALLAN STD DEV.
HDEV = Overlapping HADAMARD STD DEV.



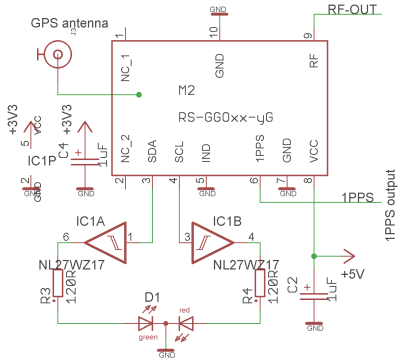


Application circuits

Controller Application



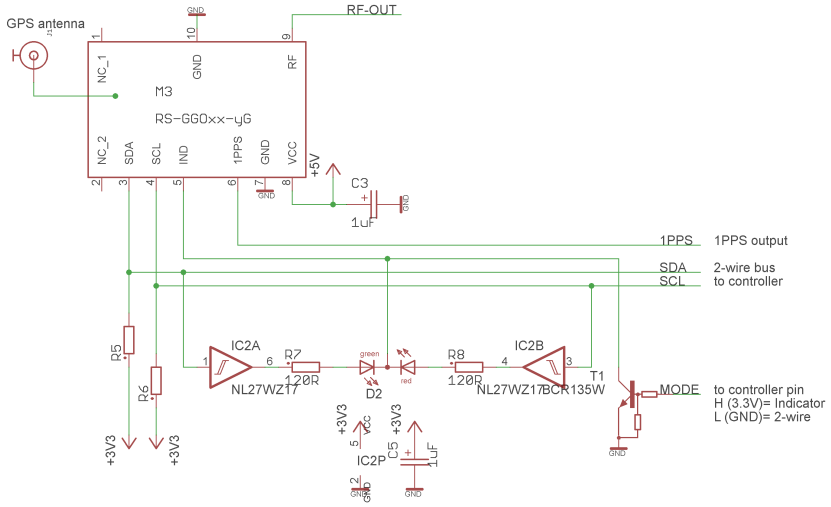
Indicator LED Application



A series capacitor in the RF-out line has to be used if the RS-GGOxx-TG is not connected to an input which operates with a 3.3V CMOS signal.

Caution: DO NOT DRIVE the 2-wire interface from a 5V bus!

Controller & Indicator Application



When switching from LED indicator to 2-wire mode DO NOT read on the bus within 100msec!

Due to the nature of the internal TCXO the temperature of the RS-GGOxx-TG has to be well controlled to achieve the desired stability! Temperature drift has to be kept below 0.1C/100sec which can be achieved by installing the RS-GGOxx-TG in an enclosure with sufficient insulation and out of the way of any fan or other devices generating rapid changes in temperature. It is recommended to use at least 10mm of a good insulation material around all sides of the RS-GGOxx-TG and to not leave any openings where airflow could make it through. Without these precautions the RS-GGOxx-TG will not be able to achieve specifications!