GPS Synchro Master

1. Introduction



GPS Synchro Master is a device on DIN bar for the generation of ON-OFF impulses and sequences (selectable by dip-switch) whose temporal accuracy is entrusted to the Quectel GPS receiver L70.

The driving output is in NPN open collector configuration, self-limited in current (therefore protected from short circuits).
It is equipped with an additional relay output (NC/COM/NO) for signalling anomalies. Its functionality can be extended thanks to the RS232 interface with which the operating parameters can be set or the NMEA strings extracted to use the module as a GPS receiver for other applications.

2. Technical features

- Supply voltage.....from 12 to 60 Vdc
- Maximum power.....< 3 W
- Maximum rated current on pin OUT (short circuit).....50 mA
- Alarm relay contact.....120 Vac / 1 A
- sequence and synchronization timing accuracy.....< 1ms
- Operating temperature.....-20 ℃ / +70 ℃
- Serial connection parameters…….....9600 8-N-1

3. nstaller instructions

Connector for COM RS232
RESET button, must be activated whenever the DIP SWITCHES (M, F, D) are repositioned
Jumper: Leave open to silence the BUZZER

BUZZER
GREEN LED: Power present
BLUE LED: GPS satellite detection: flashing from 0 to 3 satellites visible, steady on if 4 or more satellites visible (Synchronized PPS signal)
YELLOW LED: output signal monitor (OUT 1)

Group

Description

Aeolian
Square
generic

MicroSwitch Group F			
F1	F2	F3	Frequency flash per minute
off	off	off	*20*
off	off	ON	*22*
off	ON	off	*25*
off	ON	ON	*28*
ON	off	off	*30*
ON	off	ON	*40*
ON	ON	off	*50*
ON	ON	ON	*60*

IN 24VCC (min 12 Max 60)

I
N
0
V



RED Led monitor RS232 TX
GREEN Led monitor RS232 RX

4. Dip-switch setting

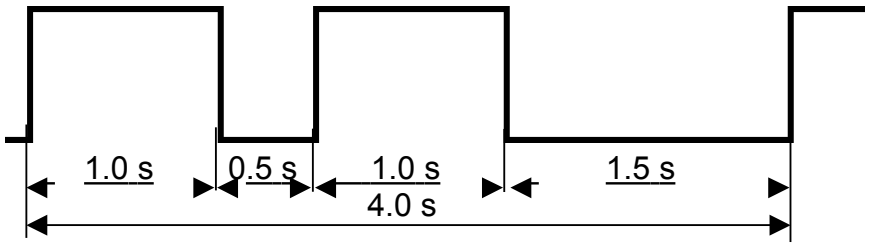
To set the sequence to be performed, the top cover needs removing with a screwdriver and act on the three groups of dip-switches which we will call M, F, D.
Group M establishes the operating mode while the remaining two groups, group F (repetition period) and group D (impulse duration), are the parameters of the chosen mode.
By varying the status of the M group, the Synchro Master can be set to operate in three modes:

MicrSwitch Group D

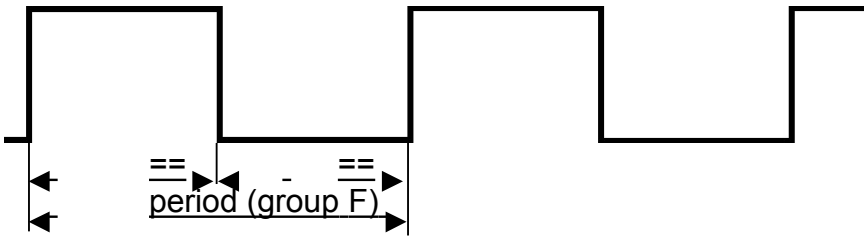
D1	D2	D3	D4	D5	D6	Flash Duration ms
Off	off	off	off	off	Off	200
off	off	off	off	off	ON	250
off	off	off	ON	ON	off	300
off	off	off	ON	ON	ON	350
off	off	ON	off	off	off	400
off	off	ON	Off	off	ON	450
and so on in Binary code in steps of 50 milliseconds...						
ON	ON	ON	off	off	off	1600
ON	ON	ON	off	off	ON	1650
ON	ON	ON	ON	ON	off	1700
ON	ON	ON	ON	ON	ON	1750

M1	M2	Function	Parameters
ON	X	Aeolian	None
off	ON	Duty cycle 50%	F
off	Off	Duty cycle variable	F, D

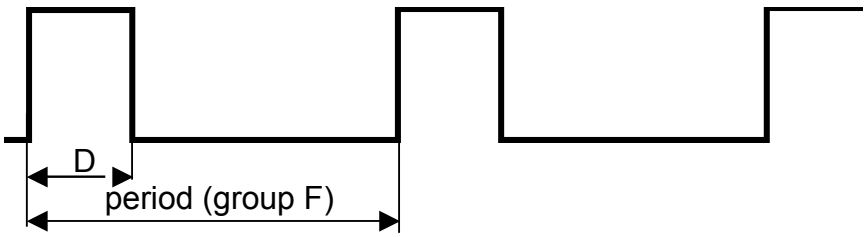
aeolian



square wave with duty cycle 50%



square wave with generic duty cycle



Below are the tables to follow to correctly set the dip-switches F and D relating to the parameters:

F1	F2	F3	Frequency (flashes per minute)
off	off	off	20
off	off	ON	22
off	ON	off	25
off	ON	ON	28
ON	off	off	30
ON	off	ON	40
ON	ON	off	50
ON	ON	ON	60

D1	D2	D3	D4	D5	Flash duration (msec)
off	off	off	off	off	200
off	off	off	off	ON	250
off	off	off	ON	off	300
off	off	off	ON	ON	350
off	off	ON	off	off	400
off	off	ON	off	ON	450
off	off	ON	ON	off	500
Continuing in binary code according to the formula Duration = 200 + D * 50 [msec]					
ON	ON	off	ON	ON	1550
ON	ON	ON	off	off	1600
ON	ON	ON	off	ON	1650
ON	ON	ON	ON	off	1700
ON	ON	ON	ON	ON	1750

5. Parameters

The module uses some parameters for its operation which can only be modified through a serial connection via a PC (chapter 7).
Below is the list of parameters and their default values present in the module:

#	Name	Description	Default
1	TIM_BEEP	Delay from the loss of the satellite signal to the indication via buzzer [sec]	**300**
2	TIM_GPSKO	Delay from loss of satellite signal to ALL_OK relay fall [sec]	**43200**
3	TIM_LED	Delay from the loss of the satellite signal to the indication by flashing of the blue LED [sec]	**30**
4	LCD_ENABLE	0: display disabled, 1: display enabled	**0**
5	TIM_GPSOK	Delay from the return of the satellite signal to the reclosing of the ALL_OK relay [sec]	**60**
6	TIME_ZONE	Time zone in hours + 12 (example: for Italy (+1) Set 13)	**13**
7	INIT_GPSOK	Initial state of the ALL_OK relay (0: open, 1: closed)	**0**
8	LEAVE_ALL_NMEA	Disabling unnecessary NMEA messages (0: eliminate them, 1: leave them)	**1**
9	ROUND_MSEC	Rounding to the second of the milliseconds provided by NMEA messages	**0**

6. Operating principle

When aligning with the GPS signal, the module indicates correct operation with the blue LED constantly lit and the alarm relay is kept closed.
As soon as the alignment with the satellites fails, the module signals this anomaly with a beep every second, with the blue LED flashing and opening the alarm relay contact.
When switched on, the module starts with the flashing cycle set via the dip-switches even if the GPS signal received is not yet sufficient for synchronization (it may take a few minutes); as soon as the GPS Synchro Master aligns, the flashing cycle is immediately corrected and from this moment it will remain synchronized.

Alarm filtering
To filter the anomaly reports, three timeout parameters are provided (`TIM_BEEP` [1], `TIM_GPSKO` [2] e `TIM_LED` [3]) which, expressed in seconds, evaluate how much time must pass before actually signalling the anomaly with the buzzer the relay and the blue led.
When the GPS aligned conditions are restored, the alarms via buzzer and LEDs fall off.
However, it is possible to indicate an anomaly return timeout for the relay (`TIM_GPSOK` [5]) in order to evaluate how many seconds of "good" signal must pass before the alarm is reset.
These filters are useful because the signal from the satellites may fail for a few seconds at certain times of the day, or in the "cold start" phase it may happen that before stabilizing the receiver provides momentary "good" signals alternating with conditions of misalignment and by filtering any false alarms can be ignored.
It is also possible to specify in which state the signalling relay must be at switch-on (`INIT_GPSOK` [7]), subsequently the behaviour of the relay will follow the behaviour described with any filtering times set.

NMEA messages
The internal GPS module is able to send various NMEA messages, but not all of them are necessary for the system to function (for current use, in fact, only the $GPGGA message is used, for further information on NMEA messages, please refer to the plentiful documentation on the web); Synchro Master automatically disables those not required to avoid unnecessarily burdening the serial traffic.
The cancellation of unwanted messages is signalled by a series of beeps when the module is switched on. Usually this sequence occurs the first time the system is turned on, since the GPS Synchro Master module subsequently keeps its settings in memory for about 6 hours.
If you want to make full use of the GPS functions by enabling, for example, other messages for use with PC software, it is necessary to exclude the internal message disabling function by bringing the relative parameter to 1 (`LEAVE_ALL_NMEA` [8]).
It is clear at this point that if some messages have been previously deleted, it is necessary to manually restore them by sending the appropriate enabling strings described in the Vincotech datasheet to the GPS module.

Display (optional)
An external display can be connected to the system for extended display of the various position data and connection to the satellites, similarly to the UDISTAT strings. The `LCD_ENABLE` [4] parameter enables communication with the display, if present.

MicroSD card (optional)
GPS Synchro Master is designed to house a MicroSD memory card: with this function it is possible to perform various logging operations.

Temperature sensor
The module is equipped with a 1Wire technology temperature sensor, the internal temperature can be read via the serial line with the command $UDISTAT (chapter 7).

System time
The time displayed by the UDISTAT strings is taken from NMEA messages that provide Greenwich Mean Time without including any daylight saving time.
To set the time zone of the area you are in, simply change the parameter `TIME_ZONE` [6] by entering the time zone of your area plus 12 hours.
For example, the time zone of Italy is +1, so the parameter must be set to 13 (14 in the case of summertime).

PPS synchronization
Synchro Master uses the PPS (Pulse Per Second) pulses provided by the integrated GPS module to synchronize.
Each PPS pulse is always successively accompanied by an NMEA string transmitted by the GPS module indicating the exact moment in time in which this pulse occurred.
This information includes the hour, minutes, seconds and any milliseconds.
In conditions of alignment with the satellites, the PPS pulse is synchronized with the GMT time at the "zero" millisecond of each second.
In conditions of misalignment with the satellites, the GPS module continues to provide the PPS, but an estimate of the drift of this signal is also calculated internally, so that the millisecond field starts to deviate from "zero" (positive or negative).
The `ROUND_MSEC` [9] parameter allows you to choose how to use the estimate provided by the GPS module.
If this parameter is set to zero, the milliseconds provided will be taken into account in the internal synchronization calculation, so any drift of the PPS signal will be corrected by the estimate evaluated by the module.
If this parameter is set to one, the estimated milliseconds will be rounded off and therefore not taken into consideration: any drift of the PPS signal will not be automatically corrected since each pulse received will be internally interpreted as synchronized to the "zero" millisecond of each second; in this way it is possible to evaluate the real deviation of the PPS with respect to a module aligned with the satellites.
It is advisable to keep this parameter at zero since it guarantees the lowest synchronization offset in case of misalignment with the satellites.

7. Serial interface

The connection parameters to be set are 9600 bit/s, 8 data bits, no parity, 1 stop bit.

When switched on, the Synchro Master sends the name and version of the software on the serial line. Through the serial line, in addition to the Synchro Master's proprietary commands and parameters, it is also possible to send commands directly to the GPS module and read its responses.
For all commands concerning the GPS module, the Synchro Master remains transparent and therefore all the packets are internally hijacked without particular settings by the user who will simply have to send the desired command, furthermore, by enabling the reading of the packets sent by the GPS, it is possible to use the module with the most common software for managing GPS receivers.
To use the L70 GPS module, please refer to the official datasheets downloadable from the site https://www.quectel.com

The command string must be sent in a single transmission (for example, it is not possible to write commands by hand via a terminal, as the communication would time out and the packet would be discarded).

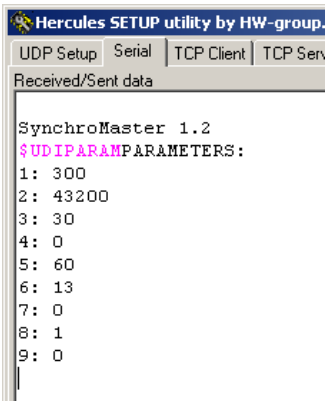
All commands start with '$' and end with <CR> (ASCII code: 0x0D), they are not case-sensitive: a different packet format is automatically discarded.

Below is a list of available commands with examples of their use:

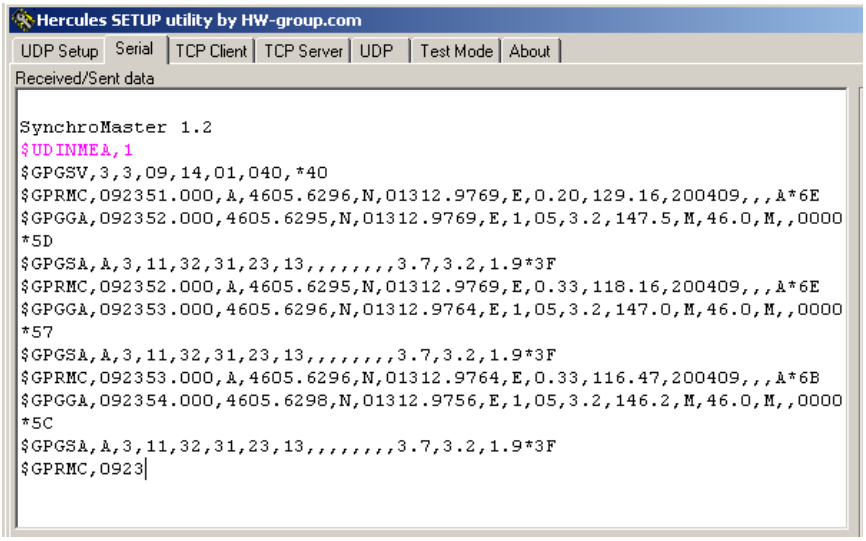
Command	Description
$UDIHELP	Provides a quick overview of all usable commands.
$UDISTAT	Prints time, number of satellites in view, internal temperature of the module and, if there are enough satellites in view, the coordinates and height in metres.
$UDISTAT,1	Enables the automatic display of $ UDISTAT every second.
$UDISTAT,0	Disables the automatic display of $ UDISTAT every second.
$UDINMEA	Prints all NMEA messages from the GPS module for the next two seconds.
$UDINMEA,1	Enables continuous printing of NMEA messages.
$UDINMEA,0	Disables continuous printing of NMEA messages.
$UDIBLINK, m, f, d	Temporarily overwrites (until the next reset) the flashing settings given by the dip-switches. m: flashing mode (0: generic [f, d], 1 duty cycle 50% [f], 2: aeolian). f: flash frequency (0: 20, 1: 22, 2: 25, 3: 28, 4: 30, 5: 40, 6: 50, 7: 60), the values indicated in red are expressed in flashes per minute. d: duration of each pulse (0 → 31: 200 → 1750 msec), according to the formula ***duration = 200 + d * 50*** [msec].

$UDIPARAM	Prints the list of parameters currently in use.
$UDIPARAM, n, val	Sets the parameter number n with the value *val* and saves everything in non-volatile memory (example: $ UDIPARAM, 6,12 sets the TIME_ZONE parameter to 12).
$UDIXYZTST	Test function: displays the status of the dip switches and the relay is manually piloted via the first dip-switch; the output is activated for 5 seconds over a period of 6 seconds. Reset to exit.

Example 1: print the list of module parameters (**$UDIPARAM<CR>**).



Example 2: enabling continuous printing of NMEA messages (**$UDINMEA,1<CR>**).



EMC indications

THE EQUIPMENT IS CLASS A PURSUANT TO EN 55022 AND THEREFORE SUITABLE FOR HEAVY INDUSTRY ENVIRONMENTS; IT MAY CAUSE ELECTROMAGNETIC DISTURBANCES IN RESIDENTIAL, COMMERCIAL OR LIGHT INDUSTRY ENVIRONMENTS.

Reasonably foreseeable use and exclusions of use

The equipment is intended for professional use
Respect the installation requirements shown in the manual
The device cannot cover safety functions
Do not use in ATEX environments

Declaration of conformity

I, Roberto Castaldo owner of the sole proprietorship UDICOM di Castaldo Roberto

with registered office in Via Cotonificio 47 33010 Tavagnacco (UDINE),

declare under my sole responsibility that the product

GPS Synchro Master

complies with the provisions of the Directives shown below:

► 2004/108/EC
having applied, as far as possible, the following harmonized standards
► EN 61000-6-1
► EN 61000-6-3

Tavagnacco, 20 April 2009

Roberto Castaldo