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JRC TECHNICAL REPORTS

IDSL Sea Level Measurement Devices

Report on the deployment and first year of work of the IDSLs in the Mediterranean area

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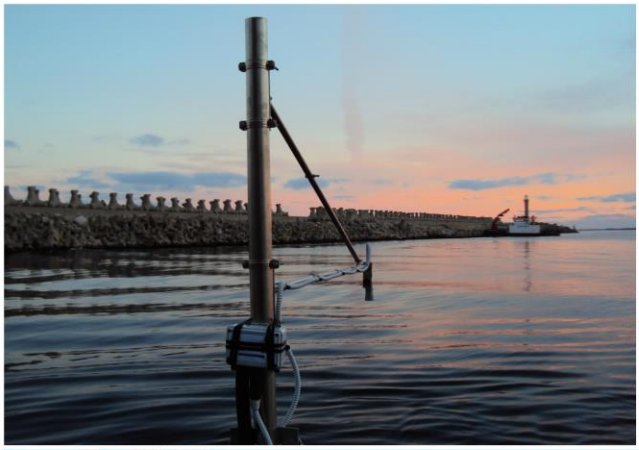

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Abstract

This report will provide details about the deployment and the operations of a set of Sea Level Measurement Devices developed by JRC in the frame of the Administrative Arrangement between JRC and DG-ECHO, and in collaboration with UNESCO.

This document will report on the present status of the sensor network and will detail the problems met during the deployments and the operational phases together with a set of statistics on the devices' performances.

Based on this experience, the report will describe the future perspectives of the project.

1 Introduction

In the frame of the Administrative Arrangement between JRC and DG-ECHO, JRC developed a relevant activity on Sea Level measurements, in order to support the Member States of the North East Atlantic and Mediterranean Tsunami Warning System (NEAMTWS) of UNESCO to improve the monitoring capabilities of Tsunami events.

The objective of the work package was the installation of two floating GPS devices in the Atlantic Sea, in front of Portugal Coasts. In order to achieve this objective 2 call for tenders have been organized by JRC and both received no offer. The reason was mainly due to the fact that this instrument is not yet mature from commercial point of view and no company considered appropriate to embark themselves in an uncertain activity never tested before. For this reason, in agreement with DG-ECHO it was decided to modify the work package and instead develop the following

- Installation of a Sea Level Network of Inexpensive Device for Sea Level Measurement (IDSL) in close collaboration with UNESCO/IOC
- In-house development and testing of a new instrument based on a floating differential GPS

The present report, that complements the final report of the MIC7 Administrative Arrangement, reports the status of IDSL network. Another report is being prepared to show the status of the GPS measurement device.

2 The Network of IDSL

In 2014 JRC developed a new type of Sea Level Measurement, named *Inexpensive Device for Sea Level Measurements* (IDSL)[1], in order to support the efforts of the Member States to improve the monitoring network for Tsunami that was being established. Based on the experience of other similar devices and the needs required by a Tsunami analysis, the following requirements have been fixed for the mareographs:

- High quality of the data with an error of 0.5 cm maximum (sensitivity justified by the expected error in the sea level calculations)
- Short acquisition time interval, 15 s maximum (to have a well defined sea level wave description over time)
- Small transmission latency, smaller than 30 s (this is particular important for small basins with low travel time)
- Low overall cost, less than 1.5 kEuro
- Autonomy, at least 3 days without solar irradiation (the autonomy can be increased to 7 days with an over cost and weight on the battery)

The initial experimental campaign organized by JRC in collaboration with ISPRA, showed very positive outcome for the first 6 months of continuous operation. This convinced the UNESCO/IOC to accept the proposal of JRC to test 20 new devices for an extended experimental campaign of at least 1 year. The new devices will be installed during 2015 and will be an important contribution to the development of the UNESCO Tsunami Early Warning System that is being built in the Mediterranean Sea and connected seas (Marmara and Black Sea) and North Atlantic areas.

2.1 The agreement with UNESCO/IOC

The Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas (ICG/NEAMTWS) was formed in response to the tragic tsunami on 26 December 2004, in which over 250,000 lives were lost around the Indian Ocean region. The Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO) received a mandate from the international community to coordinate the establishment of the Tsunami Warning System.

One of the most important activities of the Warning Centers is Collection, record, processing and analysis of sea level data for confirming and monitoring the tsunami or for cancelling elements of the alert system Given the lack of instrumentation is some parts of the Mediterranean Sea this activity in some cases is not easy.

For this reason, the European Commission decided to support the development of the system by offering the installation of 20 devices to the countries that are part of the NEAMTWS. After an international call of interest, the following countries expressed interest to have a device.

[1] A. Annunziato - THE INEXPENSIVE DEVICE FOR SEA LEVEL MEASUREMENTS –Tsunami Society International - ISSN 8755-6839 http://www.tsunamisociety.org/344Annunziato.pdf

Turkey	4
Italy	3
Romania	3
Finland	2
Maroc	2
Spain	2
Tunisia	2
Egypt	1
Greece	1
Lebanon	1
Portugal	1
Sirya	1
Togo	1

In agreement with UNESCO and taking into account the installation possibilities a selection was done and Finland, Egypt, Syria and Togo have been for the moment excluded from the installation. The installation activity was preceded by a detailed survey activity, in order to be sure that the installation could proceed without problems.

The installations have been performed with the support of the local authorities that requested the installations, and have been performed in the period from November 2014 up to July 2016. In some cases, the authorization for the installation was the cause of large delays.

On the basis of the installations, we have developed a guide that helped a lot for standardizing the installations and avoid obvious mistakes (Appendix A).

2.2 Current Status of the network

As of 12 June, 13 devices have been installed and are working, 4 the material has already been shipped and will be installed by mid July (2 in Tunisia, 1 in Italy, 1 in Lebanon) and 4 have been suspended. The suspension was due to the fact that no suitable place was found for the installation.

In the case of Turkey they proposed 3 places (rocks in the sea) that when the survey was performed in one of them, it was decided that it was impossible to install there. In the case of Maroc one place initially foreseen (Casablanca) suffered of a disruption due to an accident that made impossible the installation there.

	Country	Organization	Location	Zone	Range	Lat	Lon	Installation Date
IDSL-01	Italy	ISPRA	Imperia	**Tirrenian Sea**	5m	43.88	8.02	07-Nov-2014
IDSL-02	Maroc	CNRST	Saidia Marina	**Mediterranean West**	10m	35.1100	-2.2900	15-Apr-2016
IDSL-04	Portugal	IPMA	Sagres	**Atantic North**	10m	37.0102	-8.9258	08-Oct-2015
IDSL-05	Portugal	IPMA	Albufeira	**Atlantic North**	10m	37.0825	-8.2603	07-Oct-2015
IDSL-06	Spain	IGN	Cadiz	**Atlantic North**	10m	36.5418	-6.2812	05-Oct-2015
IDSL-07	Spain	IGN	Cartagena	**Mediterranean West**	5m	37.5671	-0.9790	04-Oct-2015
IDSL-10	Italy	INGV	Pantelleria	**Mediterranean Central**	5m	36.8348	11.9366	29-Feb-2016
IDSL-11	Italy	INGV	Portopalo di Capo Passero	**Ionian Sea**	5m	36.6670	15.1263	01-Mar-2016
IDSL-13	Greece	NOA	Western Corinth Gulf	**Aegean Sea**	5m	38.0961	23.1925	15-Dec-2015
IDSL-15	Turkey	KOERI	Fethiye	**Mediterranean East**	5m	36.6207	29.0922	17-Dec-2015
IDSL-18	Romania	NIEP	Mangalia	**Black Sea**	5m	43.8011	28.5950	25-Nov-2015
IDSL-19	Romania	NIEP	Costanta	**Black Sea**	5m	44.1533	28.6644	04-Dec-2015
IDSL-20	Romania	NIEP	Sulina	**Black Sea**	5m	45.1482	29.7594	26-Feb-2016
installation	Italy	INGV	Le Castella	**Ionian Sea**	5m	38.9100	17.0300	8 Jul 2016
IDSL-21	Lebanon	CNRS	Batroun	**Mediterranean East**	5m	34.2514	35.6565	26-Jun 2016
installation	Tunisia	INM	Tabarka	**Mediterranean Central**	5m	36.9597	8.7627	
installation	Tunisia	INM	Zarzis	**Mediterranean Central**	5m	33.4816	11.1196	
Installation	Turkey	KOERI	Bozcaada	**Mediterranean East**	5m			
Suspended	Maroc	CNRST	Casablanca	**Atlantic North**	10m	33.6115	-7.6110	
Suspended	Turkey	KOERI	Kemer	**Mediterranean East**	5m	36.6125	30.5742	
Suspended	Turkey	KOERI	Foca	**Mediterranean East**	5m	38.6183	26.7442	

The data are collected automatically and are visible and downloadable at the following web site: http://webcritech.jrc.ec.europa.eu/TAD_server/Default.aspx?group=IDSL

The web site contains several features, including data analysis, statistics, documentation for each and device, installation pictures and reports, monitoring tools.

2.3 Specific problems encountered and solutions

In the following the status and the problems found in each installation is reported. All the information are present online and the evolution can be followed by any user.

2.3.1 IDSL-01 – Imperia, Italy

The IDSL installed in Imperia has been located inside the Coast Guard compound, thanks to the collaboration with the Italian Institute for Environmental Protection (ISPRA). The device has been the first one installed in November 2014 and since then it is providing data that can be compared with the data from the ISPRA device, located in the same place (Imperia station from ISPRA).

The station is equipped with 2 solar panels of 25 W each and a battery pack of 42 Ah. The power consumption is about 7 W. The data are automatically transmitted to the JRC.

The device is working fine since January 2015. A few interventions were necessary at the beginning as this was the prototype.

11/11/2015 00:00	Control box and device substituted	Removed the prototype and positioned the one originally installed in Cadiz	
15/01/2015 00:00	Control box repositioned	Several changes to the device	
21/12/2014 00:00	Control box removed		
07/11/2014 00:00	Installation performed	All fine	

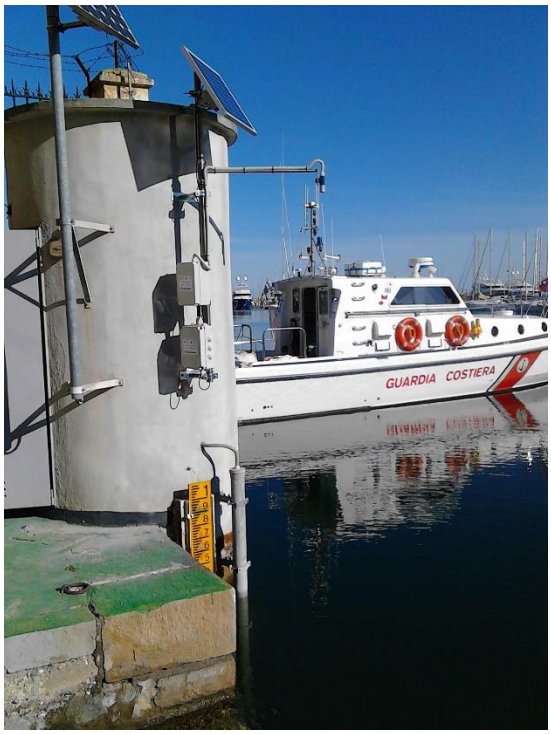


Figure 1 The Imperia device, installed onto a cabin by ISPRA in the compound of the Coast Guard

2.3.2 IDSL-02 – Saidia Marina, Maroc

The device has been installed by CNRST together with another similar instrument (the one that was installed in Casablanca). After few months of correct behaviour the sensor stopped working correctly and now it needs to be changed. We already mailed the sensor to CNRST that has not yet been able to go onsite to change it.

Date	Description	Notes	Status	Level
20/05/2016 00:00	Several interruptions in the measurements	The sensor needs to be substituted	Not working	
07/05/2016 07:00	Sudden changes of sea level noticed today. The reason could be the location of the temperature sensor inside the container box.	It would be desirable to move out the temperature sensor	Ongoing	
15/04/2016 00:00	Installation performed by CNRST Team			

Figure 2 Saidia Marina, Maroc

2.3.3 IDSL-04 Sagres, Portugal

The IDSL installed in Sagres is located in the commercial port, close to an existing obsolete mareograph. In order to keep the installation as compact as possible, a 1 m arm (reduced respect to the standard 1.5 m) has been adopted. Even if the old mareograph partly covers the exposure to the sun, it does not cause relevant impediment to the correct battery charging. In 2 occasions the sensor has been damaged by boats hitting the device. The station is equipped with 1 solar panel of 50 W and a battery pack of 42 Ah. The power consumption is about 7 W. The data are automatically transmitted to the JRC.

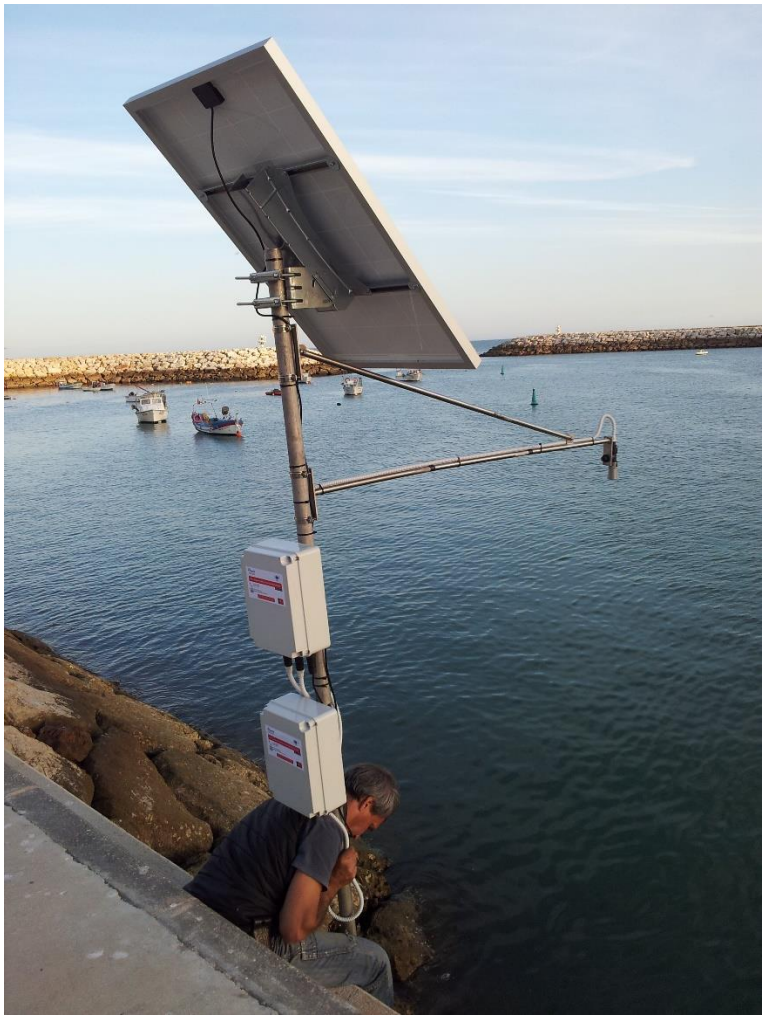
Date	Description	Notes	Status	Level
10/06/2016 00:00	The Control box has been replaced with a new one	New CB and new card	Operational	
27/04/2016 00:00	The device stopped working	Probably the card is damaged but as this device has no watch dog, it cannot restart	Need to replace the card or the device	
02/03/2016 18:00	The sensor has been substituted by IPMA team	Now the device works again	Operational	
27/01/2016 00:00	During the survey, it was discovered that the sensor was strongly hit, the arm was deformed and the sensor itself rotated (picture below). This was the reason of incorrect signal in low tide. The arm has been realigned but the response is not yet optimal with several incorrect values detected.	It would be useful to: change the installation position in a more boat free location and in that occasion to replace the sensor with a new one	Ongoing	
19/01/2016 00:00	Something hit the sensor and since then we have a shift of the signal of about 20 cm in comparison with Albufeira. During low tide the sensor is unable to give the correct signal	Necessary to reset the position of the sensor onsite	Survey done 27 Jan	
08/10/2015 00:00	Installation: Report			


Damage to the sensor on 19th January 2016.

2.3.4 IDSL-05 Albufeira, Portugal

The sensor is installed at the entrance of Albufeira Marina and it is equipped with a 50W solar panel and battery pack of 48 Ah. The installation was done on October, 6th 2015 and since then it worked well with some exceptions: in one occasion its Flash memory was corrupted and it was necessary to change it.

Date	Description	Notes	Status	Level
10 Jun 2016	Substituted the Control Box with V2		OK	
04/12/2015 00:00	Changed the memory card, watch dog removed	In the future it is necessary to change the control box with V2	OK	
15/10/2015 00:00	In order to avoid the problems occurred in Cadiz with the watch dog, the periodic restart has been eliminated	Necessary to cut the watch dog wire		
07/10/2015 00:00	Installation performed			

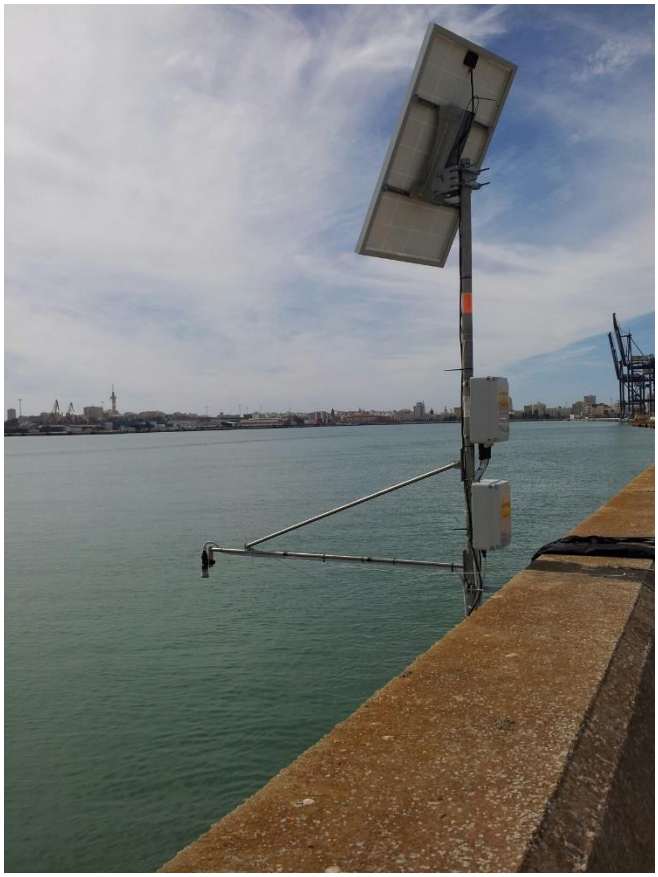


2.3.5 IDSL-06 Cadiz, Spain

The IDSL installed in Cadiz is located in the commercial port, on the external side of the bank of Port America Yacthing Club, facing the entrance of the large port.

The station is equipped with 1 solar panel of 50 W and a battery pack of 42 Ah. The power consumption is about 7 W. The data are automatically transmitted to the JRC.

Date	Description	Notes	Status	Level
16/11/2015 00:00	Control Box substituted			
14/10/2015 00:00	Device stopped working due to a misconnection of the memory card	Necessary to go onsite or replace the device		
04/10/2015 00:00	Installation performed			



2.3.6 IDSL-07 Cartagena, Spain

The IDSL installed in Cartagena is located at the edge of the commercial port, in the area of the refinery. The sensor was positioned on the side of the wall facing North East and a long cable of about 50 m has been attached to the wall protected by a plastic pipe.

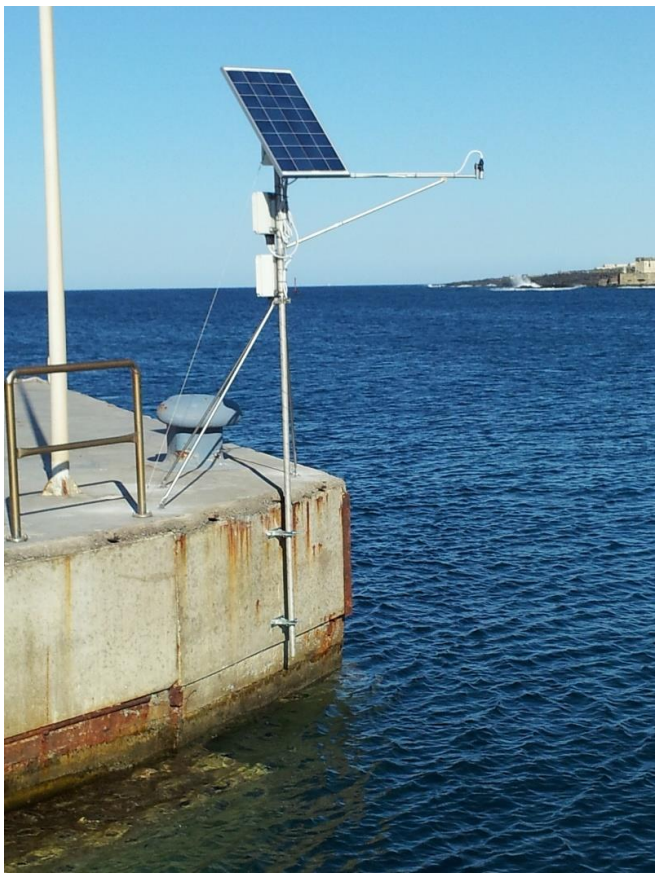
The station is connected to AC power, present onsite; a backup 7 Ah battery is installed inside the control box. The consumption is about 7 W. The data are automatically transmitted to the JRC.

Date	Description	Notes	Status	Level
18/04/2016 00:00	Memory card substituted and restarted			
02/04/2016 00:00	The memory card was corrupted	Need to change it		
02/03/2016 00:00	The sensor has been changed and risen			
16/01/2016 00:00	Since 16 January the sensor started to give wrong oscillating values and since 21 January no data is transmitted to JRC as valid data	Necessary to change the sensor, now foreseen in the second half of February	Ongoing	

2.3.7 IDSL-10 Pantelleria, Italy

The sensor has been installed with a solar panel, which required a retention tripod, given the strong windy conditions. It was not possible to fix the pole low enough to be well constrained along the wall and the tripod is required to oppose the strength of the wind against the panel. The device worked well until 5th June, when problems with the solar panel regulator appeared and are now being checked.

Date	Description	Notes	Status	Level
10/06/2016 00:00	After cleaning now it seems improved. This morning restarted to transmit	Need to check for some days/weeks		
09/06/2016 00:00	The voltage of the batteries show anomalies in charging and finally after 3 days of oscillations stopped for low voltage	A visual inspection revealed no problems to the panel but the connector has been cleaned		
01/03/2016 10:00	Changed sensor with 10m range	Working well		
01/03/2016 00:00	Problems to the sensor	Try changing the sensor with a new one	several interruptions	
29/02/2016 00:00	Installation		Operational	



2.3.8 IDSL-11 Portopalo di Capo Passero, Italy

The IDSL device in Portopalo has been installed on March, 1st 2016 in the western port structure, at the end of the walkable dock. After the installation, a very strong storm occurred which posed some problems in the data collection, because the sensor is unable to measure when very stormy conditions with foam and white water are present. For this reason, JRC/INGV and ISPRA are discussing to identify another more suitable position for this device. In any case the data are arriving to the JRC server as expected.

Date	Description	Notes	Status	Level
17/03/2016 00:00	JRC provided INGV the new sensor	The new sensor has been installed		
10/03/2016 00:00	The sensor stopped working	Need to be changed		
02/03/2016 00:00	Completed the installation of tension wires			
01/03/2016 00:00	First part of the installation	Need to finalize the installation with tension wires and second pole support		

2.3.9 IDSL-13 Corinth, Greece

The IDSL installed in Corinth is located at the entrance of the commercial port, below the lighthouse, in a very windy and high sea level location; in fact some preliminary analysis shows that in some periods of the year large waves are present in this site.

The station is equipped with 1 solar panel of 50 W and a battery pack of 42 Ah. The power consumption is about 7 W. The data are automatically transmitted to the JRC.

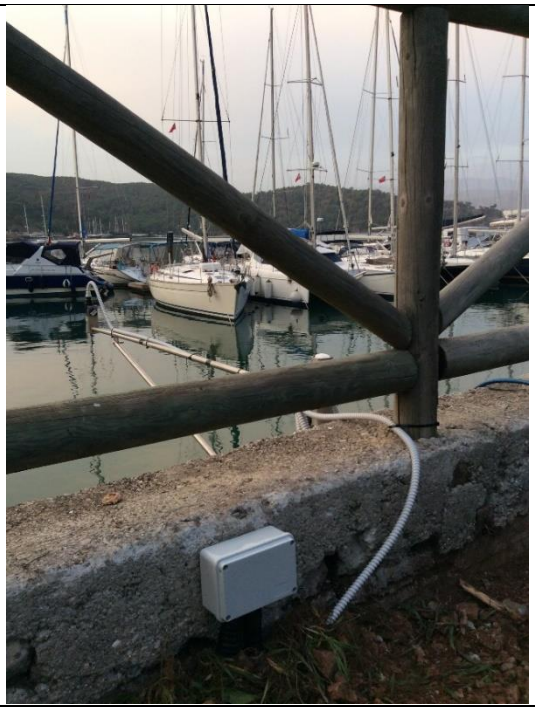
Date	Description	Notes	Status	Level
24/03/2016 11:00	A new mission was conducted at the site and several corrective actions have been implemented: the sensor and the control box have been changed, the connecting plugs have been substituted as infiltration of water was detected, the pole has been raised by 11.5 cm	Now the behaviour is much more stable with the new sensor (10 m range) we have not yet out-of-range values. Nevertheless this is a very wavy position and we must expect strong level oscillations in case of bad weather.	Online and working correctly	
14/03/2016 07:00	The data collection is still erratic. We believe that the reason is due to salt deposits on the sensor surface.	There is the need to change the sensor and replace some damaged parts of the device	Ongoing	
12/03/2016 00:00	Memory card changed and arm elevation increased by 50 cm	Need to check the response. It was found that the solar panel cable was oxidized and detached.	Online but power very low. Blackout is expected	
09/02/2016 00:00	The device stopped transmitting data and is no longer reachable	It is necessary to change the memory card and also invert the position of the arm to rise it	Offline	
15/12/2015 00:00	Installation: Report			

2.3.10 IDSL-15 Fethye, Turkey

The IDSL installed in Fethiye is located at the end of Fethiye bay, in the Boat House compound, an area of the local municipality. Given the position of the installation, the signal shows some 30 min period oscillations that are due to the local amplification. Some drop changes were present at the beginning due to a mistake in the installation of the temperature sensor which has been then corrected by positioning correctly under the sensor.

The station is connected to AC power and thus it has only a backup battery of 7 Ah. The power consumption is about 7 W. The data are automatically transmitted to the JRC.

Date	Description	Notes	Status	Level
23/04/2016 10:00	Moved the temperature sensor under the level sensor, replaced the memory card	The reason for the move of the temperature sensor was the presence of sudden level changes that have been attributed to the bad placement of the temperature sensor. The memory card was changed because of risk of failure due to high number of writes	Completed	
25/01/2016 14:30	Power restored to the device, battery recharging		Completed	
25/01/2016 00:00	On 25 Jan Fethiye stopped working due to loss of AC power after about 17 hours of backup battery. Reason for blackout is being analysed	Restore power to the device; eventually increase the backup battery size	Solved	
17/12/2015 00:00	Installation: Report			

	
The installation of the sensor in a rather shallow water place	The sensor in Fethye and the incorrect positioning of the temperature sensor which was far from the sensor. This has been then moved on the other side of this wall.

2.3.11 IDSL-18 Mangalia, Romania

The IDSL installed in Mangalia is located at the entrance of the port, in an area where a cabin for the lighthouse operation is located. This gave the possibility to use AC power to the control panel. The data are automatically transmitted to the JRC.

Date	Description	Notes	Status	Level
09/05/2016 00:00	The memory card has been substituted		Completed	
09/04/2016 00:00	The memory card appears faulty and the system does not transmit data			
29/01/2016 15:00	The sensor has been substituted with a new one and the arm inverted in order to raise it by 70 cm. During the change some salt crystals have been found inside the connection between the sensor cable and the 50m connection box.	Data are now flowing correctly	Completed	
26/01/2016 00:00	Intermittent transmission of data from Mangalia	Possible cause ice formation on the bottom face of the sensor	Ongoing	
25/01/2016 15:00	The memory card has been changed with another image	Mangalia restarted to transmit correctly the data	Completed	
25/01/2016 00:00	On 24 Jan Mangalia stopped to transmit data to the server. Analysis is going on to understand the reason for it. The system is not reachable from JRC VPN	Try to reset the device; if not working substitute the Memory card	Solved	
25/11/2015 00:00	Installation: Report			

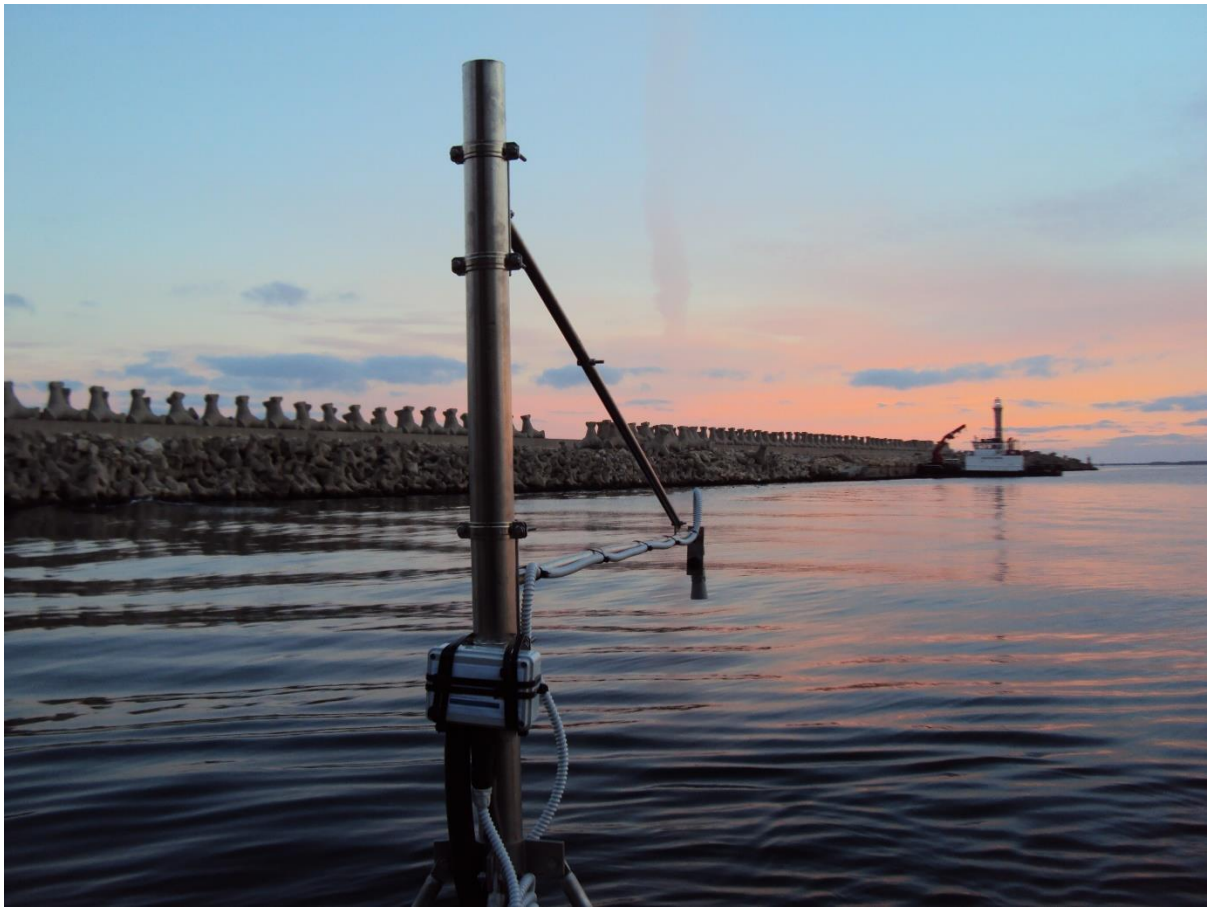
2.3.12 IDSL-19 Costanta, Romania

The IDSL installed in Costanta is located at the entrance of the internal section of the port, in an area where a cabin for the lighthouse operation is located. This gave the possibility to use AC power to the control panel.

The port of Costanta has a very long protection wall and therefore oscillations are to be expected in the signal.

The data are automatically transmitted to the JRC.

Date	Description	Notes	Status	Level
04/12/2015 00:00	Installation: Report			



2.3.13 IDSL-20 Sulina, Romania

The installation in Sulina is rather peculiar, because there is not a port where the device could have been easily installed. However, an existing sea level installation is present and is composed with a long pipe ending in the sea and connected on-shore through a well. The sensor was installed looking into the well, like another existing instrument also deployed there.

Apparently, the two instruments do not interfere with each other and we have good data from Sulina, but the dynamics of the pipe and the well are not clear and a comparison with the other instruments already installed (Costanta and Mangalia) will be useful.

The data collection device is positioned in an instrument room where other instrumentation is present. A long cable connects the sensor and the control box.

Date	Description	Notes	Status	Level
26/2/2015 00:00	Installation performed by E. Murat (NIEP)			

2.3.14 IDSL-21 Batroun, Lebanon

The installation has been performed as foreseen in the Survey report (Figure 1). The sensor was positioned on a rock surrounded by water in front of the BioMarine Institute buiding. The IDSL is attached to an aluminium pylon on top of a concrete basement. This is a challenging solution, which provides a very good observation point of the tide. In front of the sensor, the sea depth is about four meters, even if right below the radar sensor it is only 1,5 meters deep, due to an underwater rock.

The installation was smooth and rapid, the only concern being the traffic allowed by the SIM card installed in the modem router. Observing the traffic generated in the day after the installation, it was possible to size the GSM contract properly, allowing the required quantity of data per month (approximately 4,5 Gb). On the other end, the 3G signal is good and up to the requirements.

The JRC was also provided by the GeoPhysics Institute with the data taken by a similar sensor located in Beirut harbour, that were used for comparison. After some adjustments (sea level offset to be comparable and referring both data sets to UTC), the sensors show a good accord (see Figure 5).

Date	Description	Notes	Status	Level
23/6/2015 00:00	Installation performed			

Survey location inspection

Installation completed

2.4 Statistics of functioning

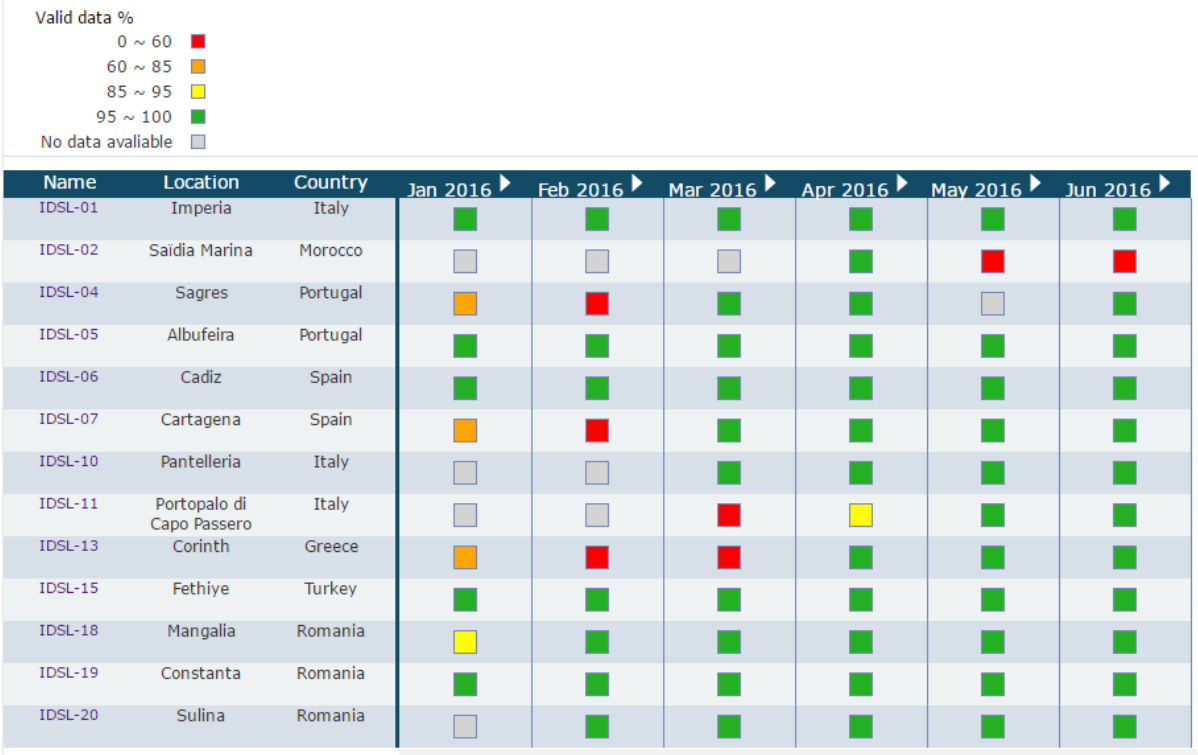
Since the beginning of 2016 very detailed statistics are present on the TAD web site for each day and for various parameters:

- Valid Data
- Data above Max
- Data below Min
- Corrupted Data
- Average Latency
- Time without Data

We report here the main ones.

2.4.1 Valid data present on the site

This indicates the percentage of time that we have valid data. As it can be seen, some sensors worked continuously well (Imperia, Albufeira, Cadiz, Fethye, Costanta and Sulina (installed after January). Saidia Marina started having problems in May and it is still out of service. As a whole, an improving trend in stability and better behaviour is present. Batroun is not included as not yet enough data were collected.



2.4.2 Average Latency

The latency is defined as the time interval between the arrival of the data on JRC servers and the measurement time. Considering that the definition of our legend is very strict (red is latency larger than 30 s), it can be noted that until May only one sensor (Sulina) was red; while all the others had latency lower than 10 s. In June some degradation of the latency has occurred. We don't know if this is related to a larger utilization of the GSM network by the local people that reduces the band available for the transmission. Further years will be necessary to evaluate this.

Average latency %

- > 30 sec.
- 10 ~ 30 sec.
- 2 ~ 10 sec.
- < 2 sec.
- On the fly calculation
- No data avaliable

Name	Location	Country	Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016
IDSL-01	Imperia	Italy	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.
IDSL-02	Saïdia Marina	Morocco	No data avaliable	No data avaliable	No data avaliable	< 2 sec.	2 ~ 10 sec.	> 30 sec.
IDSL-04	Sagres	Portugal	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	No data avaliable	< 2 sec.
IDSL-05	Albufeira	Portugal	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	10 ~ 30 sec.
IDSL-06	Cadiz	Spain	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	10 ~ 30 sec.
IDSL-07	Cartagena	Spain	< 2 sec.	No data avaliable	< 2 sec.	< 2 sec.	< 2 sec.	2 ~ 10 sec.
IDSL-10	Pantelleria	Italy	No data avaliable	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	10 ~ 30 sec.
IDSL-11	Portopalo di Capo Passero	Italy	No data avaliable	No data avaliable	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.
IDSL-13	Corinth	Greece	10 ~ 30 sec.	< 2 sec.	< 2 sec.	10 ~ 30 sec.	2 ~ 10 sec.	> 30 sec.
IDSL-15	Fethiye	Turkey	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	10 ~ 30 sec.
IDSL-18	Mangalia	Romania	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.	< 2 sec.
IDSL-19	Constanta	Romania	10 ~ 30 sec.	< 2 sec.	2 ~ 10 sec.	< 2 sec.	< 2 sec.	< 2 sec.
IDSL-20	Sulina	Romania	No data avaliable	< 2 sec.	10 ~ 30 sec.	< 2 sec.	> 30 sec.	> 30 sec.

3 Campaigns Results and future perspectives

As a whole the IDSL appears to be a quite efficient system. The acquisition of operational experience allowed JRC to install a system that is more and more stable.

The operational months of all the 13 devices installed is indicated in the table on the right and accounts for an average of 0.58 years per device or 8 years total.

ID	Installation	Oper. Months	Interventions
IDSL-01	07-Nov-2014	19	2
IDSL-07	04-Oct-2015	8	2
IDSL-06	05-Oct-2015	8	1
IDSL-05	07-Oct-2015	8	2
IDSL-04	08-Oct-2015	8	4
IDSL-18	25-Nov-2015	7	0
IDSL-19	04-Dec-2015	6	1
IDSL-13	15-Dec-2015	6	2
IDSL-15	17-Dec-2015	6	1
IDSL-20	26-Feb-2016	4	0
IDSL-10	29-Feb-2016	4	1
IDSL-11	01-Mar-2016	3	1
IDSL-02	15-Apr-2016	2	0

Some devices have been installed only recently and therefore a full statistic is not possible.

The main changes that have been performed over the months can be summarized here

- Need for a more schematic procedure for the installations: generated an installation manual (Appendix A)
- Need to reduce as much as possible the writing operations on the memory cards that suffered of early failures: modified the software to upload all the data
- Recording of all the measured data (a procedure logs all the data by uploading them and also sending them to a network based collection system)

For the future, it is necessary to foresee a regular maintenance programme. Up to now we intervened on the spot, when necessary on one or the other device. It is instead important to foresee, since the beginning, regular visits in order to

- Verify the general status of the installation, including tension wires
- Change the batteries every 2 years (4x15 euro=60 euro)
- Clean the solar panel
- Change the memory card (20 euro)
- Reinstall labels on the boxes (several of them have been damaged by sun and rain)
- If necessary substitute components: sensor (110 euro), control box (1500 euro), AC charger (if present, 30 euro) or Solar panel (60 euro)

The suggested frequency of the maintenance visits is one per year per site. The use of local personnel could allow to reduce the travel costs and should be encouraged.

The cost of the maintenance visits could be estimated in 200-300 euro as average, depending on the type of intervention required plus the travel costs. So for a network of 20 devices, 4-6 kEuro plus the travel costs should be considered.

It is good to have also a spare stock of pieces that can be easily deployed to reduce the out-of-service time. At the moment, we have 5 additional complete IDSLs in addition to the 20 that have been initially purchased. These are essential to be sent out when needed.

Final consideration about the non-assigned devices. A block of 4/20 devices has not been installed due to delays in the provision of the location or due to the installation location that was not suitable for an installation. In the future, if new devices will be installed, the survey analysis has to be very severe and only if really suitable locations are identified, the assignment should be confirmed.

Our proposal is to produce a new package of 10 devices and propose to UNESCO the offering of this new package of devices, after having verified that there is an interest in MSs to install this type of instrument.

4 Conclusion

An extensive installation campaign of IDSLs has been conducted in the period 2015-2016, so that 16 devices have been installed or are going to be installed in the next weeks. Although none of the device has been luckily measuring any Tsunami, several of them have been subject to severe storms and large sea level changes, so we are confident that in case of Tsunami they may constitute an extremely valid support for the monitoring of the Sea Level, due to their high acquisition frequency (7 data per seconds, stored every 5 s; all the data are available if necessary) and very low latency time (few seconds). All the data acquired in the EC/UNESCO-IOC campaign are available online both on JRC servers as well as on the UNESCO GLOSS web site, and thus they are available to whoever wants to use them.

The statistics on the functioning of the devices showed definite improvements over the months, but still too many interventions were needed: something remains to be done on the programming of regular maintenance visits.

Not all the devices have been installed because of the choice of the installation location that revealed to be impossible to install or because of delays in the authorization procedures. In the future it would be important to confirm the assignment only to really possible locations.

The unsigned devices (4) plus other 6 to be acquired could constitute a new package that EU could offer to UNESCO/IOC to try to improve the monitoring network: i.e. the installation in Algeria would be extremely useful as no sea level measurement is available in that area.

Appendix A – Installation Guide for IDSLs

Introduction

The objective of this guide is to explain the best sequence of operation to install successfully and put in operation one Inexpensive Device for Sea Level measurements (IDSL). The guide is the result of the installation of at least 5-6 instruments in various conditions. Reading the guide may help to have a better preparation and solve problems before they appear. Nevertheless, a degree of "improvisation" is always necessary, because each installation site is different from another and specific solutions are necessary.

The installation foresees that a preliminary survey analysis is carried out in advance in order to identify the right location for the installation which requires a number of points to be fulfilled:

1. the location should be easily accessible in case of necessity
2. the device must be installed with the sensor that is looking the sea level vertically below the sensor
3. the distance between the sensor and any obstacle around must be at least 1 m
4. the water depth below the sensor needs to be at least 1.5 m at the minimum tide level
5. the location must have a good GPRS connection (3g or 4g)
6. the area below the sensor should be kept free all the time
7. the installation has to be as close as possible to the open sea water to avoid delay in the hydraulic signal
8. Security of the place should be guaranteed as much as possible: an installation in a completely isolated place could result in potential vandalism or robbery

Two basic type of installation can be performed

- With installation of a solar panel (independent installation)
- With external electrical power

Some activities are similar for both cases, some are specific

	Activity	With installation of solar panel	With external electrical power
1	Pole installation	Yes, long pole	Yes, short pole
2a	Solar panel	Yes	No
2b	Position long cable to AC source	No	Yes
3	Arm installation on pole	Yes	Yes
4	SIM card inclusion in Router and configuration	Yes	Yes
5a	Control and battery module installation	Yes	No

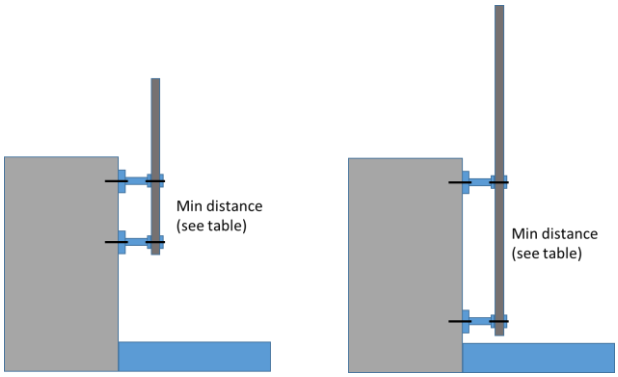
5b	AC power adapter installation	No	Yes
6	Wires connection	Yes	No
7	Wind tension wires	Yes	Yes
8	Switch on and checking	Yes	Yes

Pole Installation

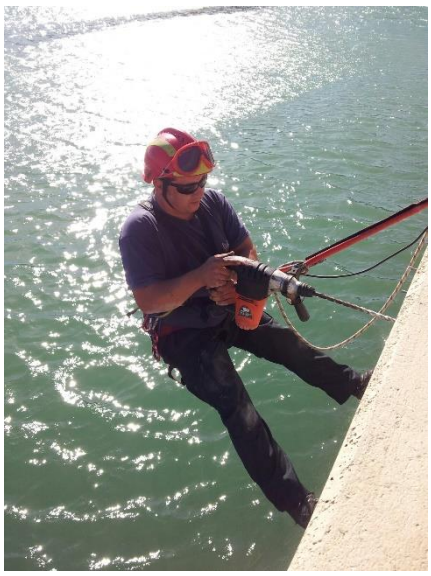
The pole installation is the most important because all the devices are then attached to the pole. So it is necessary to select a right solid vertical wall onto which the pole with its mounting supports are fixed. The distance between the two supports should be as large as possible compatibly with the vertical wall characteristics. As high is the distance as low is wind induced oscillation of the pole that is then necessary to counteract with tenso wires.

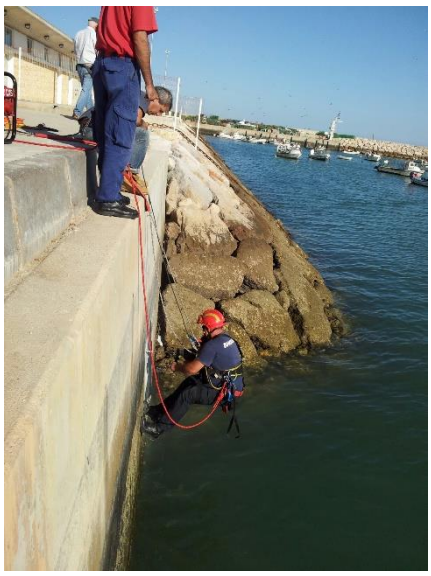
The following indications should be followed, if possible:

Pole length	Min Distance between supports	
1.5 – 2 m	1-1.8 m	Case of AC power available, no solar panel necessary
3.5-4.0 m	1.5-1.8 m	Normal distance for Solar Panel
4.0-5.0 m	2.0-2.5 m	Extended height to rise the Solar Panel



Once identified the right vertical wall that allows the fixing of the supports with their minimum distance, it is usually necessary to involve specialized personnel (Fire Fighters or Mountain specialists) that will work appended outside the vertical wall to drill and fix the supports.

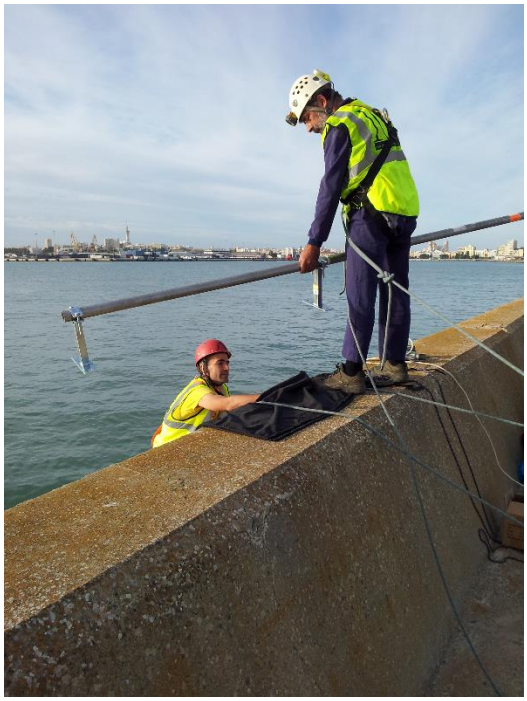


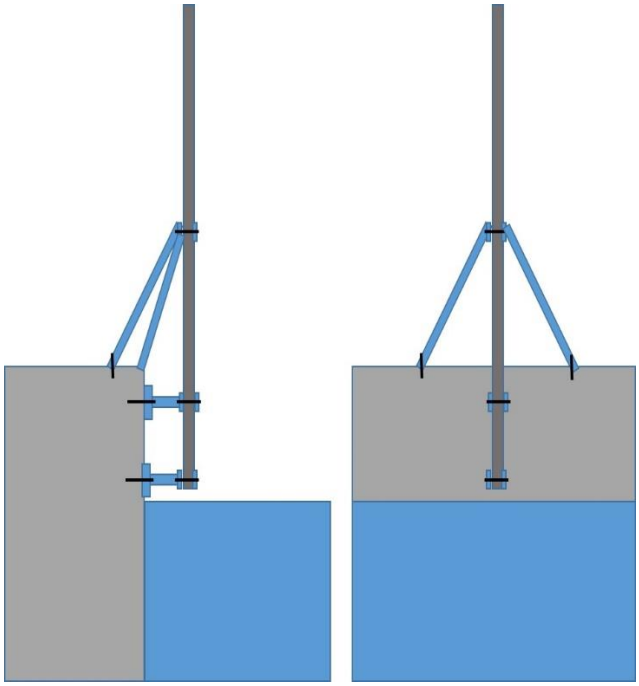


The best practice would be to fix first the upper support, then append the pole with only one support in order to find the right vertical position and then fix the lower support. This procedure however is not practical because once the first two holes are prepared with the chemical paste, the same becomes quickly solid and thus it is necessary to change to injection plastic pipe that cannot be re-used after 5-10 min.

Be careful always to apply a safety rope to everything that is not fixed. If something falls in the sea is lost. If something falls and has the possibility to fall on the earth or in the sea, *it will fall for sure in the sea*!

The normal practice is therefore: to fix the supports onto the pipe at the right distance among them, position the pole towards the wall by sustaining it with a rope, take the right points where the holes will be made using a marker, remove the pole and finally perform the holes.





In case the lower support can be part of the day under water, it is necessary to wait the low tide in order to perform the installation. This is more a problem for Atlantic Ocean locations where the tide excursion is much larger.

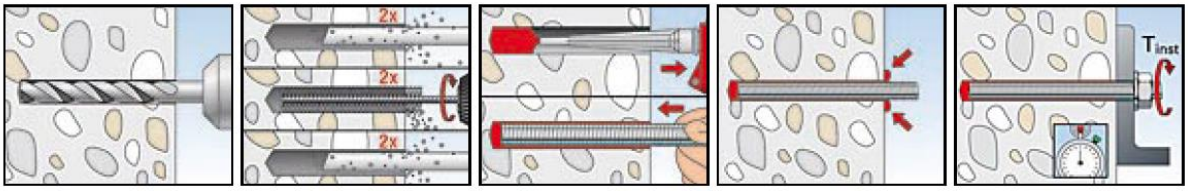
In case the minimum distance is not available, it is necessary to install oblique supports as in the figure, in order to maintain the min distance between the upper and the lower support.

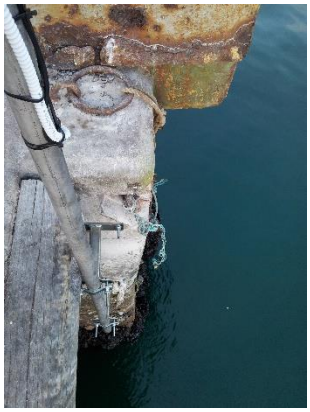
The installation of the two supports should be done using chemical anchors: a special resin inside which a screwable anchor will be positioned. The time for having a perfect blockage depends by the Temperature and by the type of material applied and should be consulted on the material technical specification. It is essential to install these with the maximum precision and fixing quality because all the installation depends on those 4 anchors**.** Example of fixing procedure is indicated below.

What is a Chemical Anchor?

Chemical or resin anchors are generic terms relating to steel studs, bolts and anchorages which are bonded into a substrate, usually masonry and concrete, using a resin based adhesive system. Ideally suited for high load applications, in virtually all cases the resulting bond is stronger than the base material itself. As the system is based on chemical adhesion, no load stress is imparted to the base material as with expansion type anchors and are therefore ideal for close to edge fixing, reduced center and group anchoring and use in concrete of unknown quality or low compressive strength. Although there are many differing variations and delivery systems in the market, all systems operate using the same basic principle with the base resin, requiring the introduction, by mixing, of a second component to begin the chemical curing process, hence the term chemical anchor.

http://www.constructionfixings.com/chemicalanchoring.htm



			
A pole installed to sustain only the sensor arm. The length is 2 m and the distance between the supports is about 1.8 m	In this case no need for wind tensors as the distance among the supports is large	In this case part of the pole is underwater during high tide	Sometimes the quality of the wall is not the best one could expect. It may be necessary to reduce the suggested height (Sagres, PT)

Power source installation

Solar Panel Installation

The solar panel needs to be prepared as it is provided all dismounted for easier transportation. In order to mount it correctly it is necessary to follow some easy indications, to avoid mounting and dismounting several times. The solar panel supports are composed of two horizontal bars that are fixed to the external frame of the solar panel with 4 hexagonal screws that have a special bolt with a sliding nut.

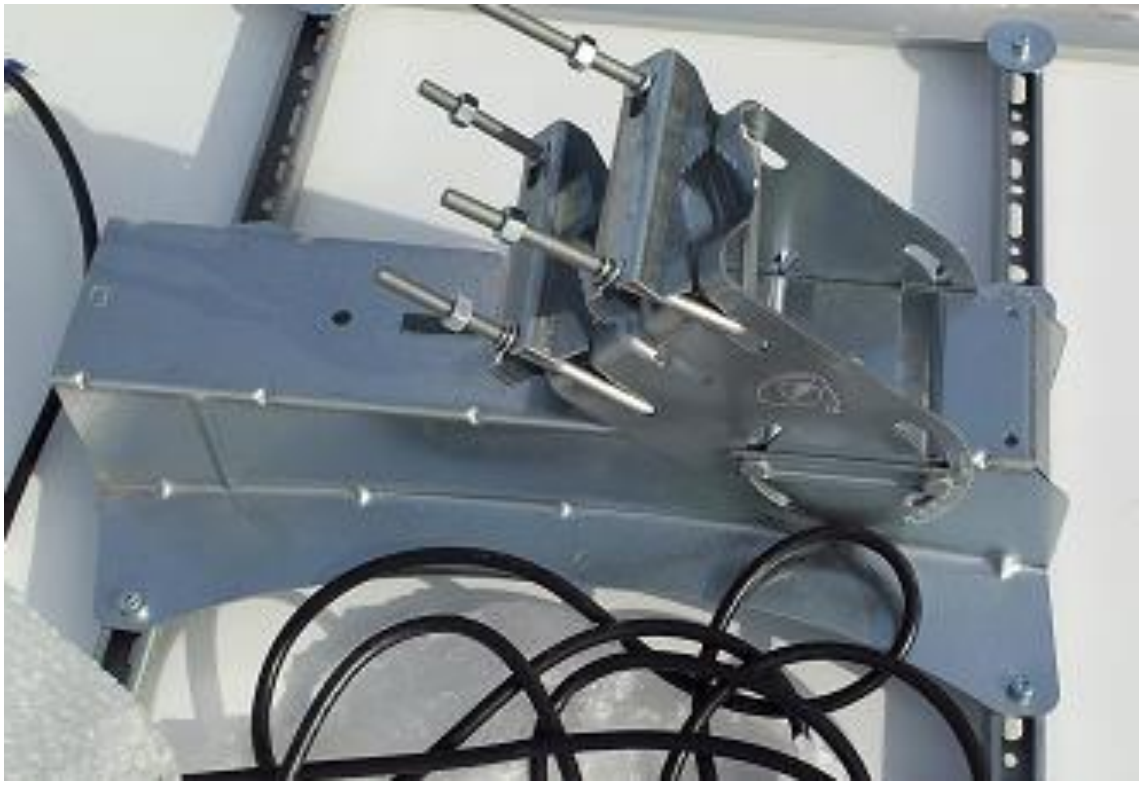
Below is the photographic sequence of the installation.

The sequence of the operations is described below:

	Insert one of the two horizontal bars inside the panel frame, in oblique position
	Rotate the bar to go below the frame at ¼ of the total vertical length of the panel
	Insert the bolt with the washer positioning the sliding nut inside the bars. Below a detail of the sliding nut. Be careful to position the nut in the direction of closing otherwise it will not fix 
	It is better not to fix completely the bar to have the possibility to a final adjustment

	Repeat the same procedure with the other bar and keep a distance between the two bars approximately 50% of the length of the panel. Again do not fix the bars strongly
	Position the structure to host the support for the pole between the two bars using similar sliding nuts and bolts. When all is well positioned you can fix firmly all the bolts.
	Please note the position of the sliding nuts when blocked in the final position, thy must appear horizontally respect to the bars to avoid to exit

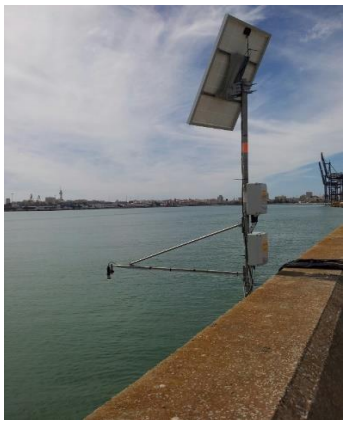
It is necessary to position the bolt correctly along the horizontal bars otherwise it will never stick to it. The final arrangement for the support is the one below. In this position it will allow to freely turn and rotate. The fixing structure is in the bottom part of the panel. The right angle of the panel depends on the latitude of installation and is in the order of 30-45 degrees.



Pay attention to the wire that must not be pulled too much to cause the removal of the contact with the electrical connections of the solar panel.

Once the mounting structure is completed, it is possible to fix the solar panel on the top of the pole. In order to facilitate the mounting of the solar panel it is possible to lower the pole to a more easy position and fix the solar panel and bend it at the correct vertical angle, then rise back the pole to its final position, including the right horizontal inclination (normally toward south).

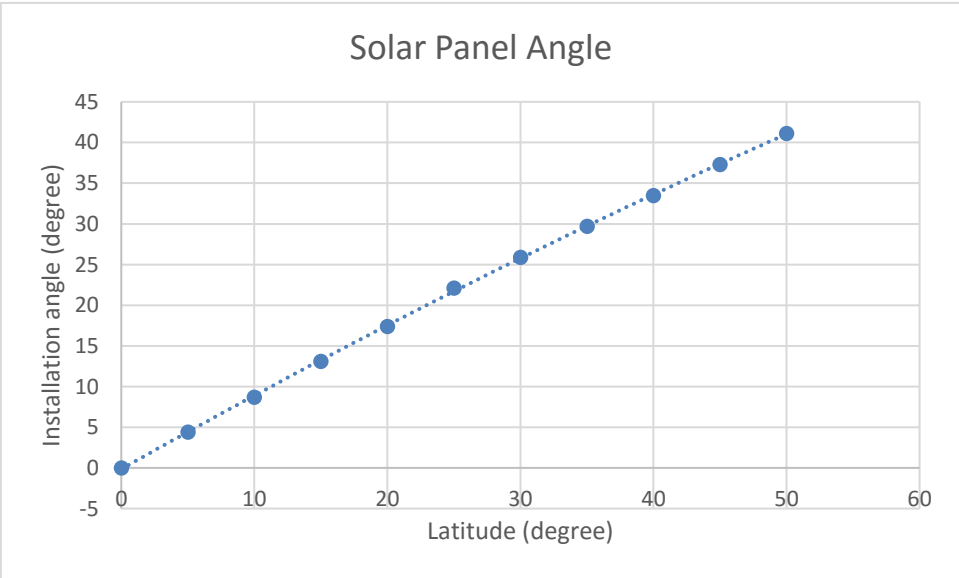
The image below shows the final position of the solar panel.



The horizontal angle should be towards south (0). The vertical orientation of the solar panel depends on the latitude of installation. The following table may serve as indication. The orientation can also be computed approximately as follows

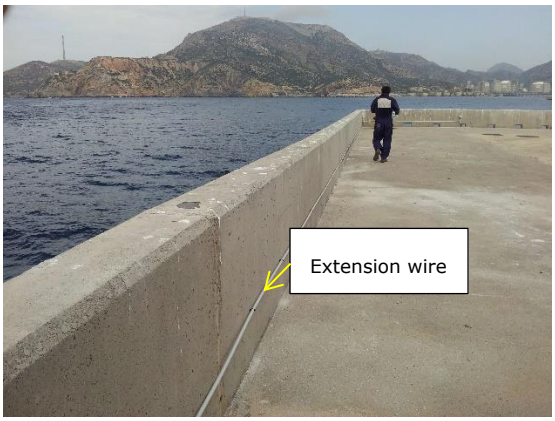
ANGLE=+ 0.9242 * LATITUDE - 0.1517

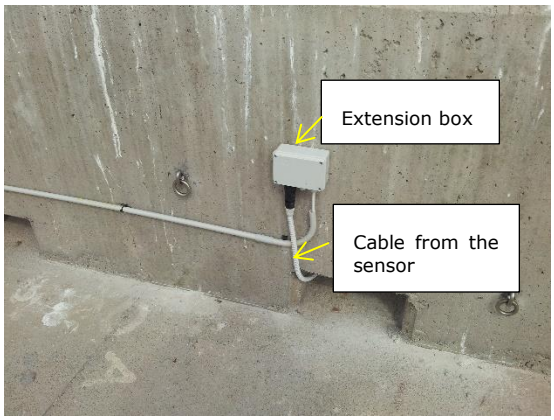
Latutude	Inst. Angle
0	0
5	4.4
10	8.7
15	13.1
20	17.4
25	22.1
30	25.9
35	29.7
40	33.5
45	37.3
50	41.1



AC power source installation

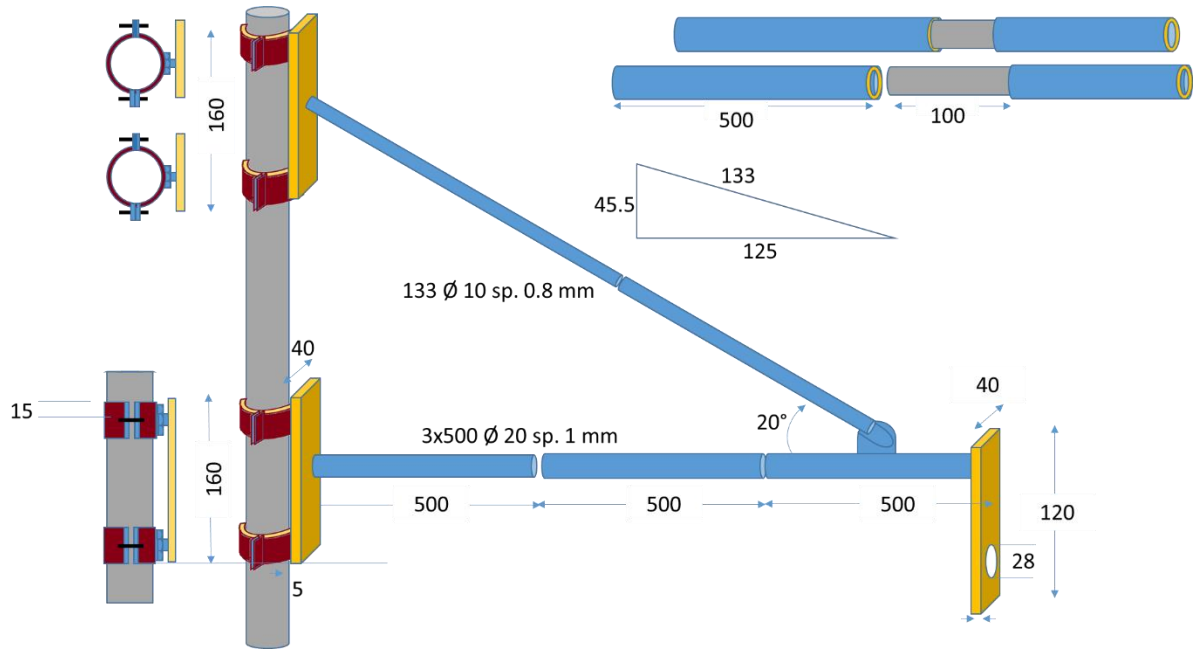
In case a local power source is available, an extension cable is provided (max length 50 m) in order to decouple the sensor area from the AC power source area. An example is given below for the Cartagena installation in which the AC power source was located in a box at about 40 m from the sensor location.





JRC provides the extension cable; this cable is planned to resist to outside conditions. It is however better to consider the installation of a plastic tube that can contain the cable and protect from sun insulation.

Sensor Arm preparation and installation

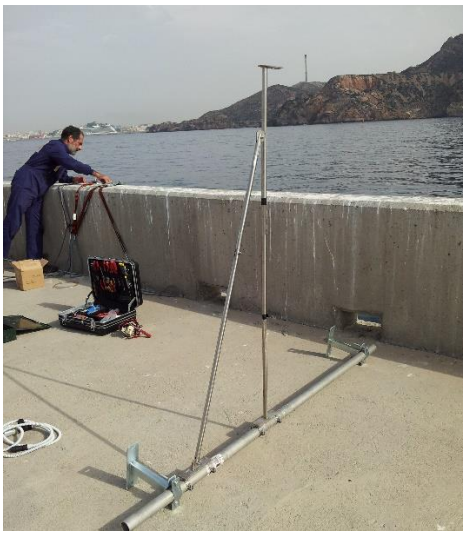


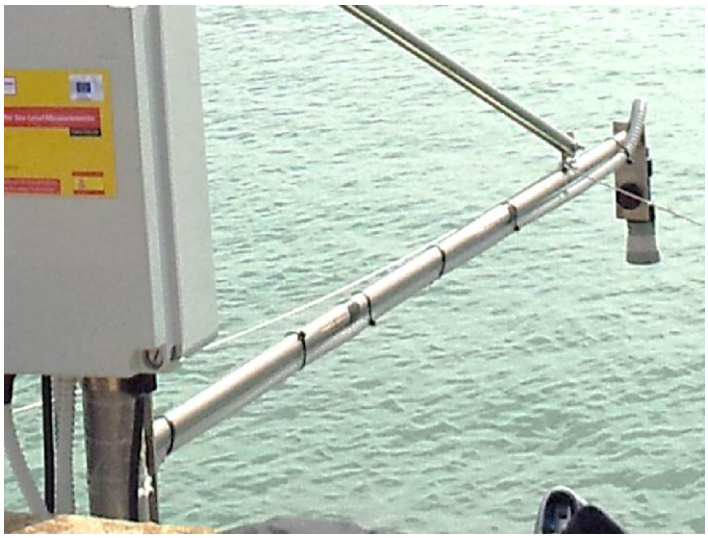
The sensor arm is composed of a number of stainless steel pieces to form a triangular shape with a final part containing a hole in which the sensor is installed. The horizontal part can be at the bottom or at the top of the triangle depending on the local conditions.

The horizontal arm can be 1.5 or 1 m long as the central section of the horizontal and the inclined structures can be removed. The use of a shorter arm can be dictated by local conditions (need to reduce the length) but the longer arm is preferable.

The various pieces must be connected by using 6 mm screws with bolts of 10 mm, provided in the package.

Once the installation of the arm is performed, it can be fixed to the pole using the screws. At this point it is possible to include the sensor and fix the sensor cable using 3 or 4 cable ties (or tie-wraps) along the horizontal pipe.





SIM Card inclusion in the router and Configuration

Generally, the SIM card is available only at the installation place. If instead the SIM is provided before the installation this step can be skipped.

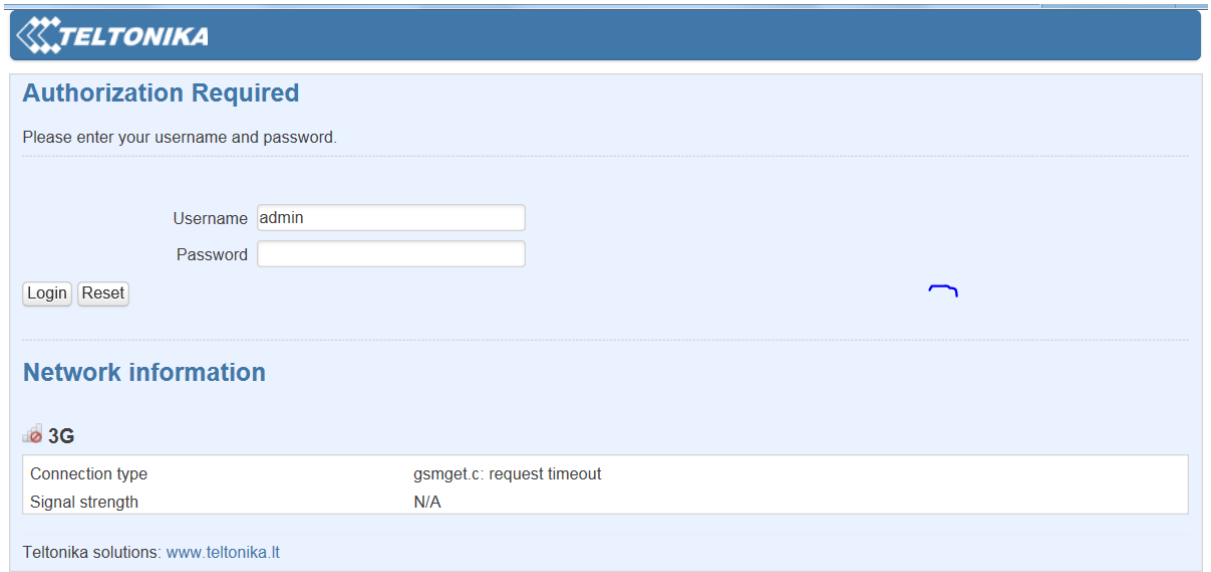
In order to insert the SIM in the router it is necessary to remove the router from the control box with a small cross screwdriver (two small screws at the side of the router), and open the router as indicated in the figure.

The SIM has to be inserted respecting the form as indicated in the figure.

Then close the router and reinstall inside the control box.

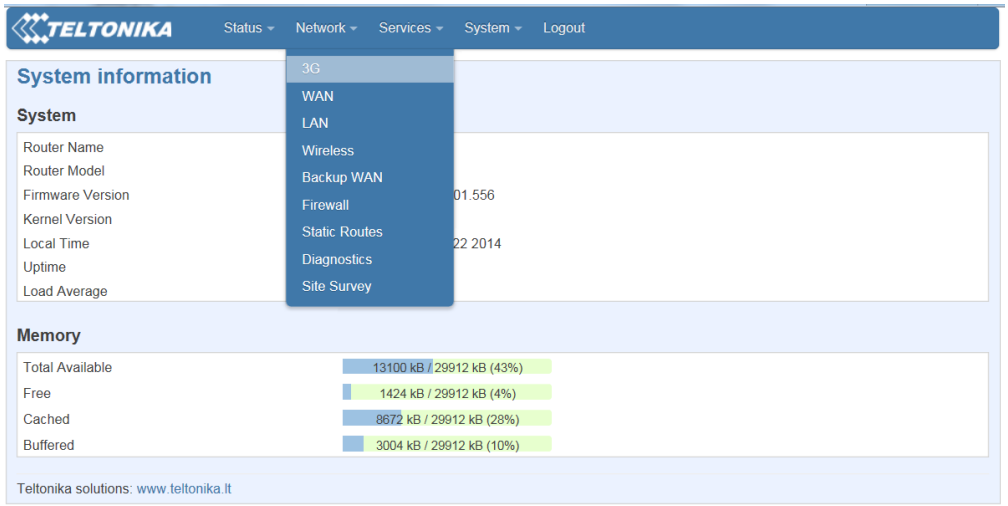
The configuration of the router must be done switching on the device and connecting with a computer using the built-in WIFI connection. Searching the WIFI network you should find a Teltonika_IDSL-xx to which you need to connect. Ask JRC for the password of the WIFI.

Once you have connected with the WIFI network, open a browser and type the address of the router: http://192.168.1.1

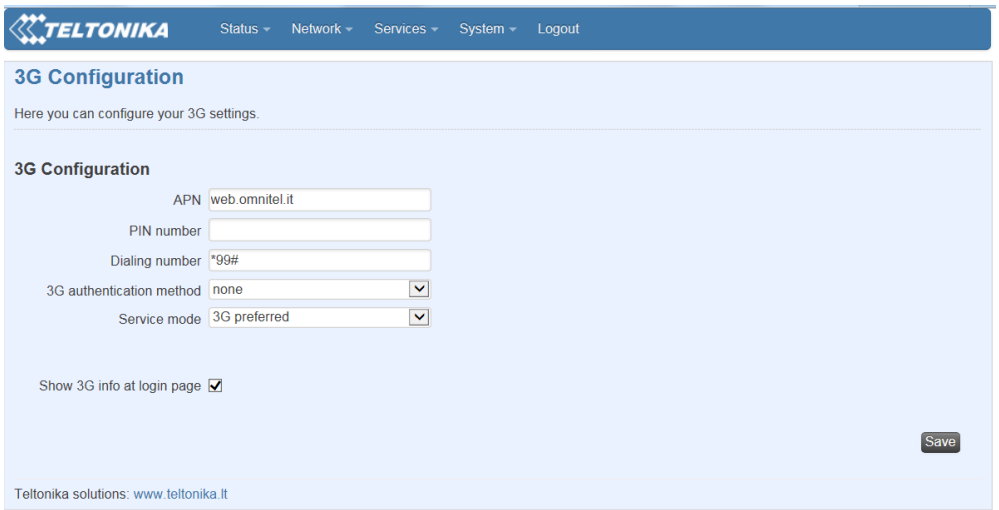


Login in the initial page indicating username admin and the password that will be given by JRC.

Then select Network > 3G as indicated below



Change the APN according to the GSM provider (in the image below web.omnitel.it) and the PIN number of your SIM card, if any. The Dialing Number in general should be left blank or *99# and the authentication mode as none. If your phone card provider require authentication, indicate CHAP or PAP from the drop down menu and a user/password fields will appear. For the service mode leave 3g preferred.



Once you completed this step save by pushing the button and you should be able to navigate in internet if the provider allows it.

In order to verify if you can navigate in internet or not, connect your PC with the raspberry using an SSH connection (ex. using Putty or MobaXTerm programs) and connecting with parameters:

192.168.1.1xx

Where xx depends on the device, so IDSL-04 would be 192.168.1.104

Username is **pi** and password is: **raspberry**

Once connected, to verify it can go in internet, give the command

wget www.google.com

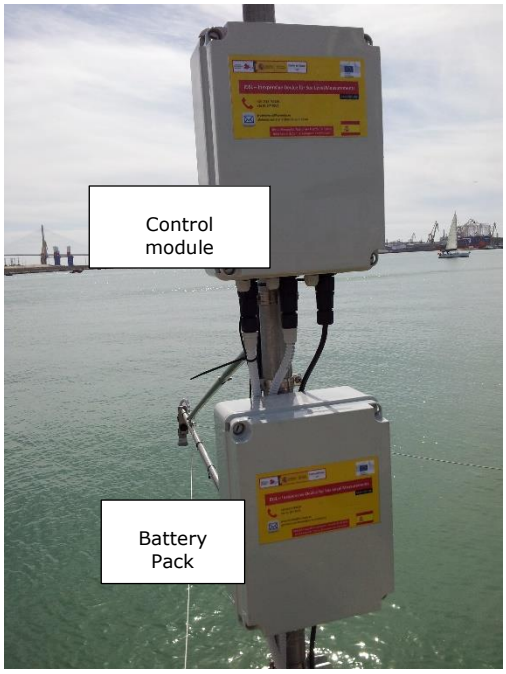
if it can go in internet it will start downloading the google home page.

Control and battery module installation

Control Module Installation

After having inserted the SIM and verified that it can go in internet, you can proceed by fixing the control module on the pole. Take into account that in case of extended flooding of this location, it is very difficult that the module will survive if immersed in water. Therefore, you should install in a high position on the pole.

The installation is quite simple, it is sufficient to un screw the 4 screws behind the panel and fix firmly the collars on the pole. Leave enough space below the control panel to allow the cables insertion.

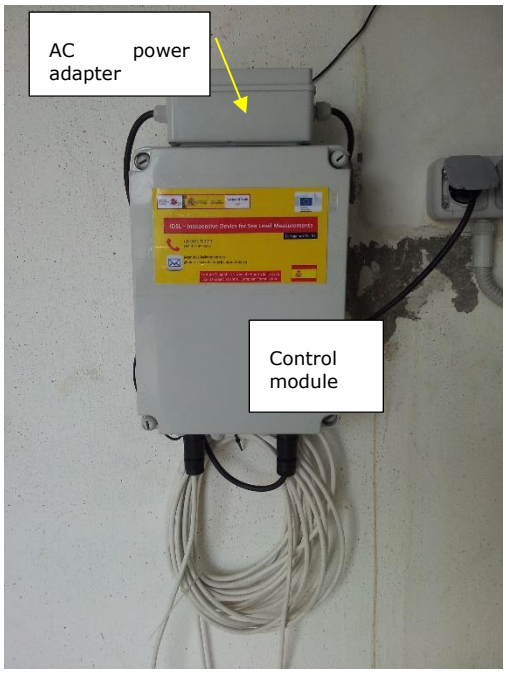


Battery Module installation

The battery module should be installed below the control module because, being much heavier it is better not to have too much weight at higher levels.

AC power adapter installation

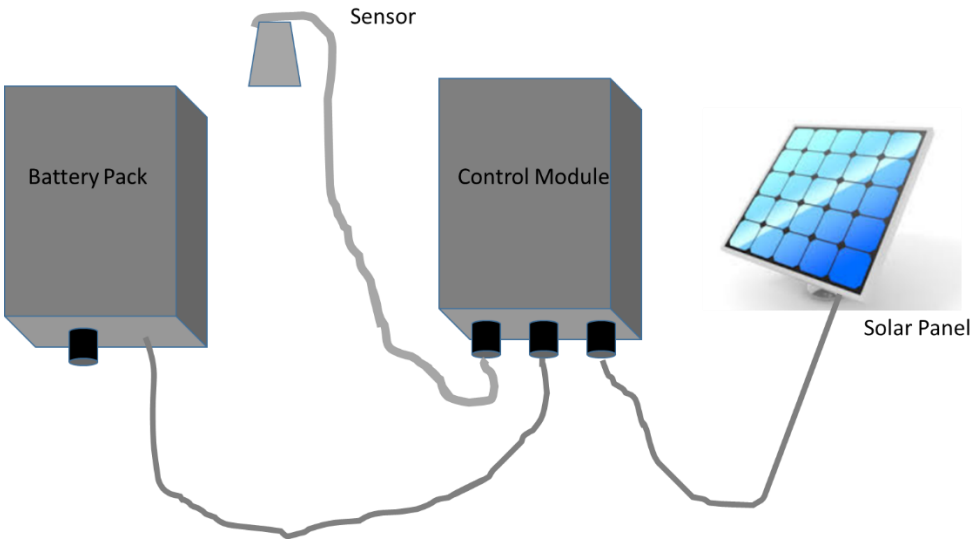
If there is AC power available (and not solar panel), the AC adapter will be positioned somewhere close to the control module.



Wires connection

At this point, the wires connection can take place following the schemes below.

The solar panel should be connected with the right connector of the control module, the sensor with the left connector and the battery pack with the central connector.



Please make sure not to connect wrongly the 3 connectors as it may damage the sensor.

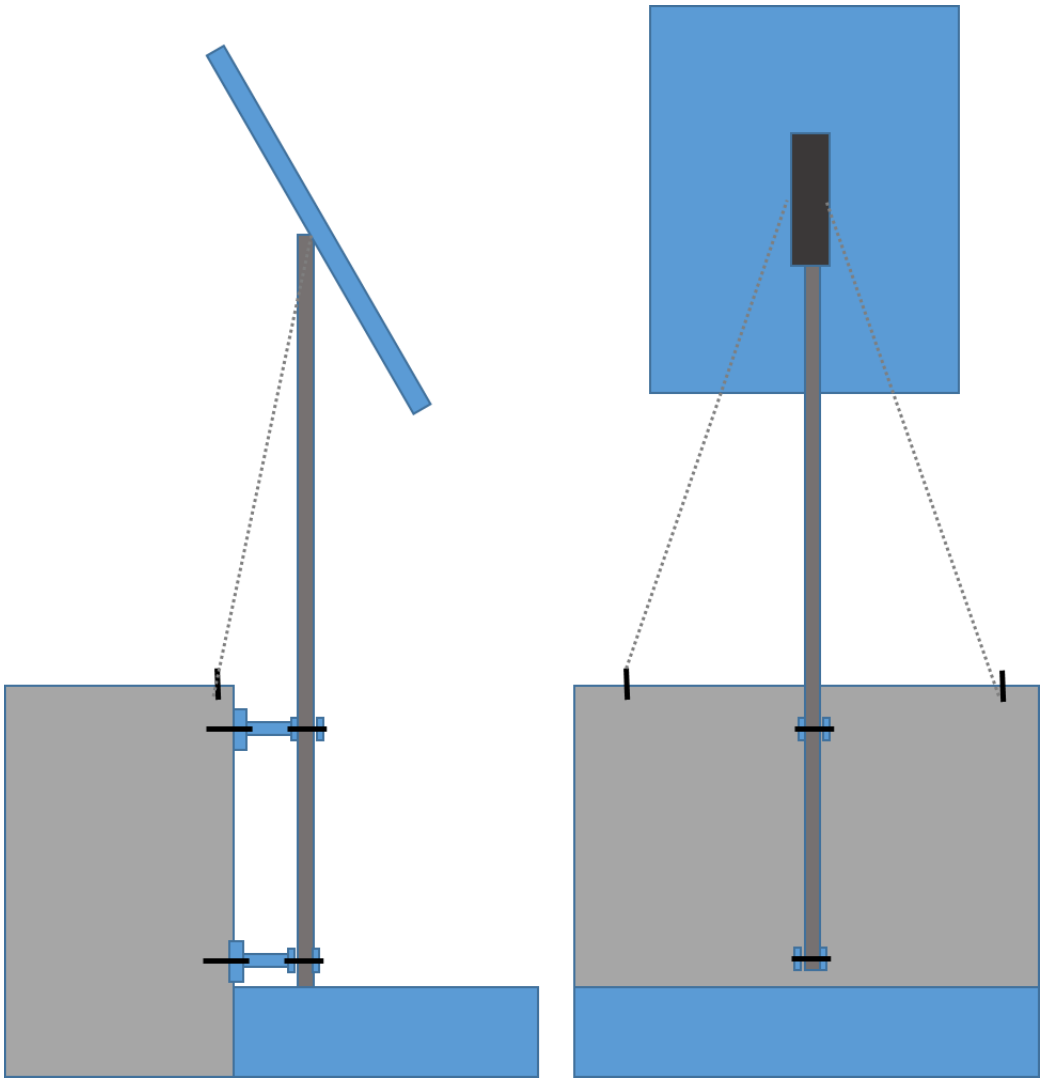
An additional free plus is present on the battery pack that could allow the connection of an additional battery pack or for measuring the battery voltage from outside, without opening the boxes.

Wind tension wires

The installation of the wind tension wire is necessary when the panel exposes the pole to wind. In some cases, when the distance between the pole support is very high or there is no solar panel, there is not a strong need for these wires, however it can be judged on a case-by-case basis.

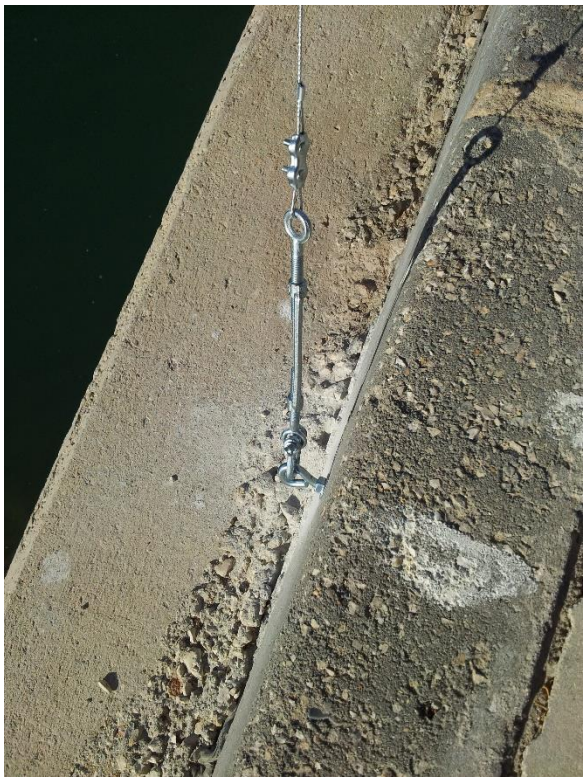
When wires are needed, there can be wires for the pole and wires for the arm. The wires are strong stainless steel wires of about 1 mm diameter that are used by fixing a ring on the ground and connecting them with the solar panel structure close to the pole. Tensors are used in order to have the right tension to the pole.

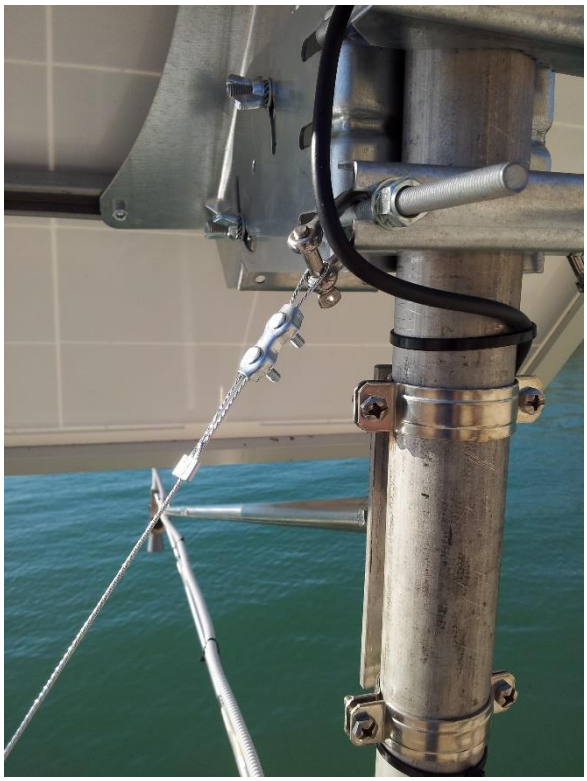
A suggested method for connecting the wires is indicated below.



The figures below indicate the details of the connection of the wires at the bottom, with the tensor, and at the top, with the solar panel. In order to fix the wires we used nautical shackles.

The two wires should not be exactly on the same plane of the pole. If they are slightly off-center, as indicated in the image above, there is also a horizontal component that helps to keep in place the pole with low oscillations.





Switch on and checking

When all is fixed, it is possible to switch on the device with the special key provided. After some minutes (2-5 min), if the device is working correctly you will see the data flowing to the JRC web site

http://webcritech.jrc.ec.europa.eu/tad_server

if the device is not listed, try to add the keyword *&test=true*

http://webcritech.jrc.ec.europa.eu/tad_server&test=true

as in some cases the devices are kept in test mode. The listing of device should include your device and indicate the latency in data transmission.

Legal notice

TAD SERVER

Institute for Protection and Security of the Citizens - JRC Ispra Site

European Commission > Webcritech > TAD Server

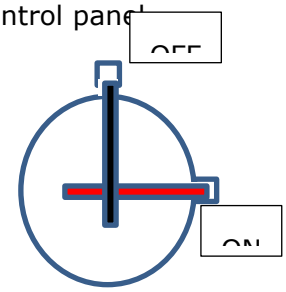
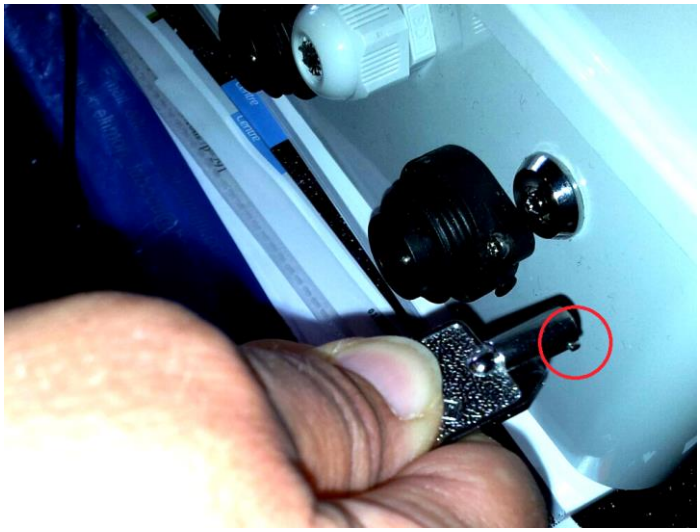
Home | Devices List | Sensor Monitor | Links | About | Login

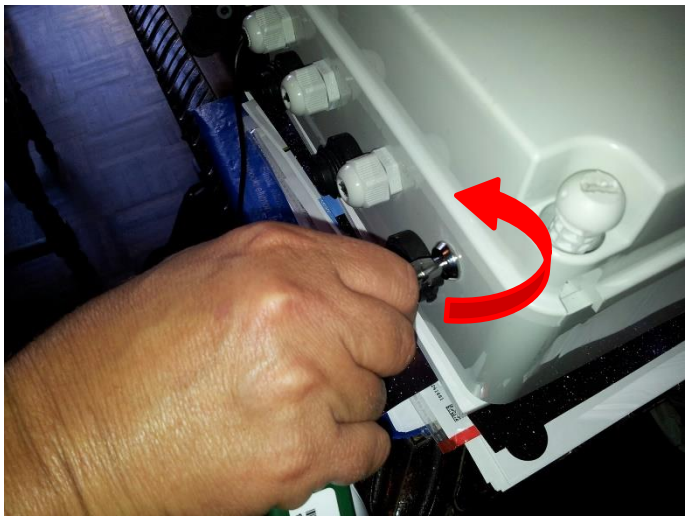
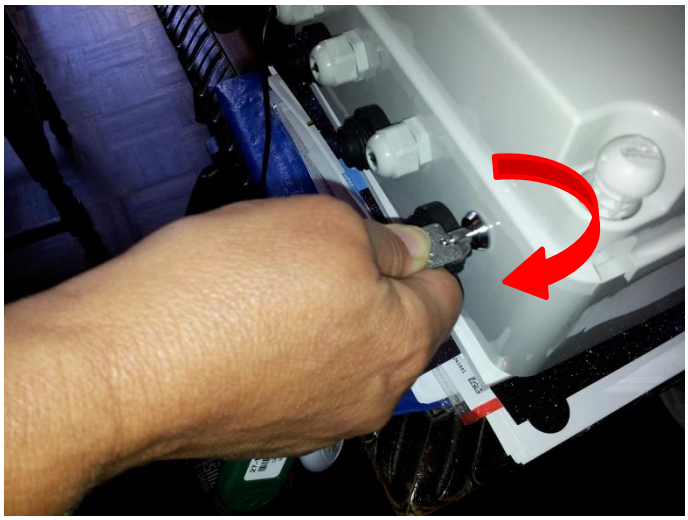
Tide gauge list

Id	Name	Sensor	Lat.	Lon.	Description	Location	Provider	Last value	Last Date	Latency
59	FCUL-IGCAS		38.69	-9.42	Cascais	Portugal(Lisboa)	FCUL	2.600	11 Oct 2015 10:46:33	23 Sec
60	FCUL-IGLAG		37.10	-8.67	Lagos	Portugal(Lisboa)	FCUL	2.558	11 Oct 2015 10:46:33	23 Sec
64	IDSL-01	RAD	43.88	8.02	Imperia	Italy(Liguria)	JRC	0.063	11 Oct 2015 10:46:53	3 Sec
77	IDSL-04	RAD	37.01	-8.93	Sagres	Portugal(Algarve)	JRC	0.493	11 Oct 2015 10:46:41	15 Sec
78	IDSL-05	RAD	37.08	-8.26	Albufeira	Portugal(Algarve)	JRC	0.629	11 Oct 2015 10:46:53	3 Sec
79	IDSL-06	RAD	36.54	-6.28	Cadiz	Spain(Andalucia)	JRC	2.165	11 Oct 2015 10:46:52	4 Sec
80	IDSL-07	RAD	37.57	-0.98	Cartagena	Spain(Murcia)	JRC	2.169	11 Oct 2015 07:00:21	3 Hours
50	IPMA-IGCAS		38.69	-9.42	Cascais	Portugal(Lisboa)	IPMA	0.480	11 Oct 2015 10:47:05	-8 Sec
52	IPMA-IGLAG		37.10	-8.67	Lagos	Portugal(Algarve)	IPMA	0.578	11 Oct 2015 10:47:05	-8 Sec
56	IPMA-IHFUL		32.64	-16.91	Funchal	Portugal(Madeira)	IPMA	2.156	11 Oct 2015 10:43:52	3 Min
54	IPMA-IHLEX		41.19	-8.70	Leixões	Portugal(Porto)	IPMA	2.415	11 Oct 2015 10:43:52	3 Min
53	IPMA-IHPEN		39.95	-8.89	Peniche	Portugal(Oeste Subregion)	IPMA	2.530	11 Oct 2015 10:43:51	3 Min
57	IPMA-IHSIN		37.95	-8.89	Sines	Portugal(Alentejo)	IPMA	2.692	11 Oct 2015 10:46:30	27 Sec

If still the device is not listed you should check again if the device is able to go in internet (see chapter 0).

How to switch off and on the Control Panel

	Identify the key switch on the right side of the bottom of the control panel 
	Note the small tooth on the switch key
	Insert the key in horizontal position (respect to the box length)

	Rotate the key anti-clockwise and put the key vertically (respect to the box length)
	Return the key in the horizontal position and extract it

Lessons Learnt from the Installations

In this chapter we try to indicate the lessons learnt from the installations performed so far that can be useful for new installation. As every installation is a new case, this chapter will evolve all the times.

1. (WHO IS INSTALLING) Use a rope to keep material and tools and avoid falling under water: anything on the sea must be secured (included the persons)

2. (LOCAL SUPPORT PERSONNEL) Bring all the appropriate tools and in particular
    a. Driller with the series of Drill Bits, including the large ones for the chemical anchors
    b. Chemical anchors glue
    c. Allen key for the solar panels
    d. Mechanical keys and at least numbers 7, 10, 13, 17
    e. Angle grinder for cutting pieces
    f. Electrical power source, either with wire or autonomous
    g. Cutter
    h. Several cable ties of various dimensions
    i. Hammer
    j. Pliers

3. Ensure that the support unit onsite has the right equipment for descending on the vertical wall

4. (JRC Personnel) Be sure to have replacement parts for:
    a. All screws, bolts, sliding nuts
    b. Router, Raspberry, power regulator or alternatively, if possible, one complete control box

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JRC Mission

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