Ajuntament de Banyoles

PLA DE SOSTENIBILITAT TURÍSTICA EN DESTINACIÓ (PSTD)
Banyoles, Ciutat de l'Aigua
Convocatòria Extraordinària 2022
Pla de Recuperació, Transformació i Resiliència,
Finançat per la Unió Europea – Next Generation EU
Actuació 1. Projecte comportes reguladores de l'estany i dels recs

PLEC DE PRESCRIPCIONS TÈCNIQUES PARTICULARS PER AL SUBMINISTRAMENT D'UN SISTEMA D'AFORAMENT DE LES RIERES I RECS D'ENTRADA DE L'ESTANY DE BANYOLES

Serveis Territorials de Banyoles

Març 2026

Finançat per
Unió Europea
Fons Europeu
Next Generation
Pla de Recuperació, Transformació i Resiliència
Next Generation Catalunya
Generalitat de Catalunya

ÍNDEX

1. INTRODUCCIÓ

El present document "Plec de Prescripcions Tècniques Particulars per al subministrament d'un sistema d'aforament de les rieres i recs d'entrada a l'Estany de Banyoles" es redacta amb l'objectiu de tenir un coneixement i registre dels cabals que aporten la Riera dels Tenyers, la Riera Castellana, la Riera de Can Morgat, el Rec de Gran de Lió i el rec a la Llacuna dels Amaradors. El coneixement dels cabals d'entrada, juntament amb la resta d'instal·lacions de mesura existents als punts de sortida d'aigua de l'Estany, permetrà una regulació més acurada dels recursos d'aigua de l'Estany.

2. ANTECEDENTS

La zona lacustre de Banyoles separa la plana de l'Empordà de la serralada Transversal, ja a la comarca de la Garrotxa. A banda del mateix Estany de Banyoles, la zona comprèn també un seguit de petits estanyols situats al seu entorn. Entre aquests hi destaquen el del Vilar, el d'en Sisó, el de la Cendra i la Platja d'Espolla.

A la subunitat de l'Estany de Banyoles, hi ha 6 rieres de tipologia torrencial: Rec Gran de Lió, el Rec de Guixeres, la Riera de Can Morgat, la Riera Castellana, la Riera dels Tenyers, la riera del Vilar i el rec de la Perpinyana. Totes elles en conques de petita dimensió i que també reben en major o menor mesura recursos no torrencials, provinents de surgències del mateix aqüífer que alimenta l'estany.

El sistema de desguàs de les aigües de l'Estany es fa a través de 6 recs pels quals passen uns 58.500 m^3/dia d'aigua (variables al llarg de l'any i en funció de la precipitació local i comarcal), que van a parar finalment al riu Terri.

L'ajuntament de Banyoles ha executat en els darrers anys les següents intervencions per tal de permetre la correcta gestió de l'aigua de l'estany mitjançant el coneixement i regulació dels seus nivells:

- Substitució de la comporta del Rec d'en Teixidor per una comporta basculant i de regulació piezomètrica l'any 2021, alhora que es va executar una millora ecològica del rec.
- Substitució de les comportes per comportes basculants i de regulació piezomètrica l'any 2024 dels recs de Ca l'Hort, La Figuera d'en Xo, Rec Major i Rec de Guèmol.

També es preveu la substitució de la comporta de la canonada de desguàs de l'Estany (canonada de Can Lero) i l'arranjament de la canonada per evitar les pèrdues actuals en la mateixa.

Amb aquestes actuacions prèvies, les sortides d'aigua de l'estany estan regulades i permeten el coneixement dels cabals desguassats i el nivell d'aigua de l'estany.

El present document té l'objectiu d'instal·lar cabalímetres al cinc rieres i recs per mesurar els cabals d'aigua d'entrada a l'Estany.

Els continguts d'aquest document estan d'acord amb el pla especial i en tot moment es preservaran les característiques d'aquests recs.

El sector Front d'Estany es defineix en el Pla especial *com l'espai d'interès paisatgístic i ambiental. Comprèn la transició entre l'Estany i la zona urbana consolidada, on els recs estan oberts, amb unes lleres cobertes de vegetació, amplades considerables tant del vas com de l'espai urbà que l'acompanya i amb una presència destacable d'espècies que s'han de protegir*.

El mateix document estableix com a normativa general proposada, entre d'altres:

- *Manteniment de les característiques de la vegetació lacustre, amb tala selectiva, protecció de la fauna que s'hi ha incorporat en el primer tram d'estany amb bosc de ribera pel seu entorn immediat.*

- *Obligacions de mantenir en bon estat les lleres, els passos i safarejos en bon estat.*
- *Definició dels límits de les edificacions a les ribes dels recs amb la incorporació de la definició dels materials i alçada de les tanques d'horts i jardins que limiten amb el rec o el seu pas.*
- *Fixació de l'amplada mínima dels pas dels itineraris.*

3. OBJECTE DEL CONTRACTE O NECESSITAT A COBRIR

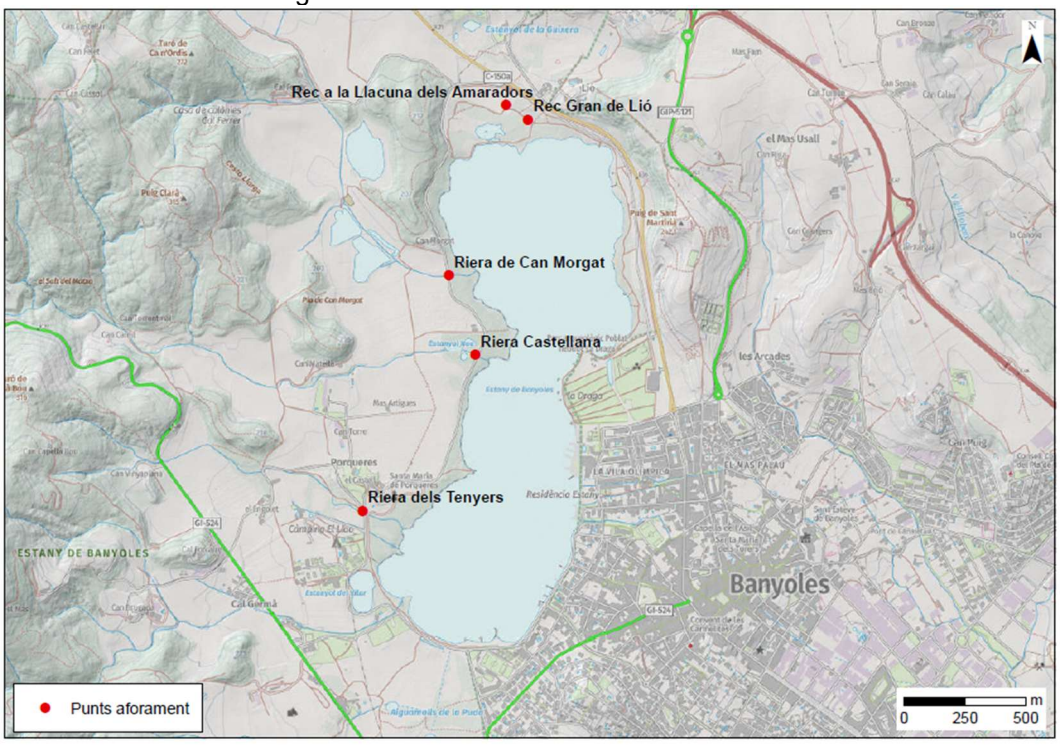
3.1. ÀMBIT I LOCALITZACIÓ DE LES INSTAL·LACIONS

L'àrea d'intervenció comprendrà 5 punts ubicats en diverses rieres i recs que aporten cabals d'aigua a l'Estany de Banyoles: la Riera de Tenyers, la Riera Castellana, la Riera de Can Morgat, el Rec Gran de Lió junt i el rec a la Llacuna dels Amaradors.

Aquests recs representen els principals cursos fluvials superficials que alimenten el sistema lacustre. L'elecció dels punts d'instal·lació dels cabalímetres ha estat determinada per criteris de representativitat hidrològica, accessibilitat i idoneïtat per a la instal·lació dels equips de mesura.

La següent imatge mostra la ubicació de l'àmbit de les instal·lacions:

Imatge 1. Localització futura de les instal·lacions



La ubicació dels cabalímetres es situa sobre l'aigua dels recs, que forma part del bé comunal de l'Estany de Banyoles.

L'Estany de Banyoles és un bé comunal del municipi, i que gaudeix de la protecció jurídica que la legislació de règim local atorga a aquests béns, i en especial la imprescriptibilitat, inalienabilitat i inembargabilitat de tots els béns que el configuren

3.2. ESTAT ACTUAL DELS PUNTS D'UBICACIÓ DE LES INSTAL·LACIONS

L'àmbit de les instal·lacions es troba ubicat a l'entorn immediat de l'Estany de Banyoles, en sectors naturals de caràcter fluvial amb un alt valor ecològic i paisatgístic. Els punts identificats corresponen a quatre cursos d'aigua principals que drenen cap a l'estany: la Riera Castellana, la Riera de Can Morgat, la Riera dels Tenyers i el Rec Gran de Lió (més el rec que se'n desvia direcció a la Llacuna dels Amaradors).

A nivell general, aquests entorns presenten una vegetació de ribera ben desenvolupada, amb presència d'espècies com el salze (*Salix alba*), el vern (*Alnus glutinosa*), espècies protegides com *Carex elata subs. elata* i altres helòfits, acompanyats de freixe de fulla petita (*Franxinus angustifolia*) i vegetació arbustiva i herbàcia que contribueixen a la qualitat ecològica dels hàbitats. El llit de les rieres presenta seccions variables, amb zones de flux permanent i altres d'intermitents o amb escorrentia superficial reduïda en períodes secs. En aquest sentit un cas particular és el de la Riera Castellana, on el nivell de l'aigua pot venir donat per la cota de l'aigua de l'estany que entra riera endins.

L'accessibilitat als punts d'aforament és, en general, bona, gràcies a la proximitat a la carretera GIV-5248 i la xarxa de senders per a vianants i bicicletes a l'entorn de l'Estany. No obstant, alguns trams poden requerir tasques puntuals de desbrossament o condicionament mínim per garantir la seguretat en la instal·lació i el manteniment dels dispositius d'aforament.

Pel que fa a les alteracions antròpiques, s'observa la presència d'elements com passos de serveis soterrats, canalitzacions parcials i estructures de contenció en el pas dels recs i rieres sota la carretera i camins. Tot i així, la major part dels entorns mantenen una dinàmica hidrològica natural, amb molt bon desenvolupament de la vegetació i comunitats autòctones.

El punt d'ubicació del cabalímetre al Rec Gran de Lió serà l'estructura sobre el rec corresponent al camí de vianants de circumval·lació de l'estany. Les dimensions del rec en aquest tram són 150x90 cm.

Al rec que es dirigeix cap a la Llacuna dels Amaradors, el cabalímetre s'ubicarà a continuació del bagant existent, on ja hi ha un petit endegament amb formigó per a l'ancoratge del bagant. Les dimensions del rec en aquest tram són 100x70 cm.

A la Riera de Can Morgat s'instal·larà el cabalímetre a la sortida de la canalització de la riera sota la carretera GIV-5248, al sostre de l'estructura de pas sota la carretera a la sortida en direcció a l'estany. En aquest punt el flux és laminar i l'estructura de pas permet la instal·lació d'un sensor en un punt de geometria coneguda. Les dimensions de l'estructura hidràulica són 300x90 cm.

A la Riera Castellana, es proposa situar el cabalímetre al l'estructura hidràulica sota la GIV-5248, situat al marge oest de la carretera, que és el punt on s'observa un flux laminar més estable. Les dimensions de l'estructura hidràulica són 400x150 cm.

A la Riera dels Tenyers, la instal·lació del cabalímetre es farà a continuació de l'estructura hidràulica de la carretera, aigües avall de la mateixa (a la banda de l'estany). En aquest punt el flux és laminar, alhora que permet l'accés i manteniment, i es troba fora del pas dels usuaris dels camins de l'entorn de l'estany. Les dimensions de la llera a la sortida de l'estructura hidràulica són 130x45 cm.

3.3. ELEMENTS D'INTERÈS DE L'ENTORN

L'àmbit d'actuació es troba en un entorn ambientalment sensible, amb presència d'espais naturals protegits, hàbitats d'interès comunitari i zones amb valors faunístics i florístics destacables. A continuació es detallen els elements principals:

PLA ESPECIAL DE PROTECCIÓ, ORDENACIÓ I RESTAURACIÓ DE L'ENTORN IMMEDIAT DE L'ESTANY DE BANYLES (PEPOR)

L'àmbit es troba parcialment inclòs dins de l'àrea definida pel Pla Especial de Protecció, ordenació i restauració de l'entorn immediat de l'Estany de Banyoles (PEPOR), que estableix criteris específics de conservació i integració paisatgística.

PEIN I XARXA NATURA 2000

Els punts d'aforament es troben inclosos al PEIN Estany de Banyoles (PEIN; Decret 32/1992, de 14 de desembre), que forma part també de la Xarxa Natura 2000, amb la doble designació com a LIC i ZEPA ES5120008 Estany de Banyoles. Aquests espais tenen com a objectiu la conservació d'hàbitats naturals i espècies d'interès comunitari. Espai on és d'aplicació la Directiva Hàbitats (Directiva 92/43/CEE del Consell, de 21 de març de 1992, modificació per la Directiva 97/62/CE del Consell, de 27 d'octubre), i Directiva Aus (Directiva 2009/147/CE) i el conjunt de normes de protecció de la natura Espanyoles, Catalanes i de l'administració local.

La intervenció prevista és compatible amb la normativa d'aquests espais, sempre que es garanteixi la no alteració dels hàbitats ni afectació a les espècies protegides.

ÀREES D'INTERÈS FAUNÍSTIC I FLORÍSTIC

En l'àmbit de les instal·lacions es localitza l'Àrea d'interès faunístic i florístic segons la cartografia del Departament d'Acció climàtica, Alimentació i Agenda Rural, amb número de control 1299. La normativa a aplicar en aquestes zones és el Decret legislatiu 2/2008, de 15 d'abril, pel qual s'aprova el Text refós de la Llei de protecció dels animals; i el Decret 172/2022, de 20 de setembre, del Catàleg de fauna salvatge autòctona protegida i la seva normativa derivada.

Les espècies de fauna d'especial conservació incloses a la fitxa de la ZEC considerades elements clau de gestió de l'espai natural són *Vertigo moulinsiana*, *Vertigo angustior i Lutra lutra* (llúdriga).

Les mesures de gestió per aquestes espècies determinades a la fitxa de la ZEC són, entre d'altres, la conservació de la vegetació aquàtica i riberal heliòfita, el manteniment de les condicions fisicoquímiques de l'aigua adients, l'ordenació i/o restricció d'accés als llocs d'interès per l'espècie, i control de la creació de nous vials i infraestructures en àrees amb presència de l'hàbitat o l'espècie.

Les intervencions es duran a terme tenint en compte els valors naturals d'aquesta AIFF, i es prendran les mesures necessàries per evitar l'afectació directa o indirecta als seus elements de conservació.

CATÀLEG DE FLORA AMENAÇADA

L'àrea d'interès florístic inclou les següents espècies, amb la següent qualificació segons la Resolució ACC/3929/2023, de 20 de novembre, per la qual s'aprova la catalogació, descatalogació i canvi de categoria d'espècies i subespècies del Catàleg de flora amenaçada de Catalunya.

A l'àmbit de les instal·lacions es pot trobar *Carex elata* subsp. *elata*, espècie inclosa en la categoria "en perill d'extinció". Es tracta d'un helòfit característic de zones humides, especialment dels hàbitats de caràcter oligotròfic, com les vores i surgències de l'Estany de Banyoles.

HÀBITATS D'INTERÈS COMUNITARI (HIC)

Els entorns fluvials i de ribera a l'àmbit de les instal·lacions inclouen diversos hàbitats d'interès comunitari (HIC) segons la Directiva Hàbitats (92/43/CEE).

ZONA ARQUEOLÒGICA

El punt d'ubicació del cabalímetre de la Riera dels Tenyers es troba al límit de la zona arqueològica de Santa Maria de Porqueres.

3.4. QUALIFICACIÓ URBANÍSTICA

El Pla d'ordenació urbanística municipal de Banyoles es va aprovar definitivament per la Comissió de Territori de Catalunya el 22 desembre de 2020.

Els punts d'aforament inclosos en aquest document se situen majoritàriament en sòl no urbanitzable, amb qualificació de protecció especial per raó dels seus valors ambientals, hidrològics i paisatgístics. Segons el Plans d'Ordenació Urbanística Municipal (POUM) vigent.

Aquestes zones es troben regulades per normatives específiques de protecció territorial, incloent el Pla Especial de Protecció, ordenació i restauració de l'entorn immediat de l'Estany de Banyoles (PEPOR), la Normativa del PEIN Estany de Banyoles, així com les disposicions derivades de la inclusió dins la Xarxa Natura 2000.

Es contempla la instal·lació d'elements puntuals, de caràcter no edificatori, compatibles amb la qualificació urbanística vigent, sempre que es justifiqui l'interès general i s'acreditin les mesures de minimització d'impacte. No es preveu l'ocupació permanent de sòl, ni l'alteració significativa de l'ús del territori.

4. OBJECTIU

L'objectiu principal del present document és descriure les característiques dels dispositius d'aforament (cabalímetres) a instal·lar a cadascun dels principals cursos hídrics que desemboquen a l'Estany de Banyoles, amb la finalitat de monitoritzar i gestionar de manera eficient el balanç hídric del sistema lacustre.

Concretament, les actuacions es dirigeixen a:

- Mesurar i registrar de manera contínua els cabals d'entrada de les rieres de Can Morgat, Castellana, dels Tenyers i el Rec Gran de Lió i el rec en direcció a la Llacuna dels Amaradors.
- Obtenir dades fiables i en temps real sobre els volums hídrics aportats a l'estany.
- Millorar la capacitat de gestió del nivell de l'aigua, mitjançant el control coordinat entre les entrades naturals i les sortides regulades.
- Facilitar la presa de decisions tècniques sobre la regulació hidràulica de l'Estany de Banyoles en situacions de sequera, episodis de pluges intenses o per motius de conservació ecològica.

Aquest sistema de control hidrològic forma part d'una estratègia global de gestió sostenible dels recursos hídrics i de conservació dels valors ecològics i paisatgístics de l'estany i el seu entorn immediat.

Així, els objectius de les instal·lacions es concreten en:

- Selecció del tipus de cabalímetre.
- Dimensionament i adaptació a cada emplaçament.
- Definició dels sistemes d'alimentació i transmissió de dades.
- Compatibilització amb l'entorn i normativa vigent.

5. ANÀLISI D'ALTERNATIVES

En el marc de definició de la metodologia per al mesurament dels cabals d'entrada a l'Estany de Banyoles, s'han valorat diverses alternatives tècniques, amb l'objectiu de garantir la fiabilitat de les dades, la viabilitat constructiva i la minimització de l'impacte ambiental associat a les actuacions.

5.1. ALTERNATIVA 1. INSTAL·LACIÓ DE CANALS PARSHALL

Inicialment, es va contemplar la instal·lació de canals Parshall a les diferents rieres i recs d'entrada a l'estany, per la seva capacitat de mesurar cabals de forma directa i robusta. No obstant això, durant els treballs de camp i en consulta amb el personal tècnic del Consorci de l'Estany, es constata que aquesta solució requereix una obra civil considerable, amb afectació directa sobre les lleres dels recs i rieres i la vegetació autòctona associada, especialment impactant en les lleres més amples com la Riera de Can Morgat i la Riera Castellana. L'encaix del canal Parshall suposa un escanyament excessiu del llit, que compromet tant la funcionalitat hidràulica com la integritat ecològica dels cursos d'aigua.

En el cas particular de la Riera Castellana, on la cota de la làmina d'aigua ve donada per la cota d'aigua a l'estany que entra a la riera fins a la carretera quan està alta, el canal Parshall es trobaria anegat i no proporcionaria dades fiables.

A més, la necessitat de moviment de terres i formigonats en zones sensibles implica un impacte elevat sobre la vegetació de ribera i altres comunitats vegetals d'interès, especialment en entorns amb presència d'hàbitats protegits o d'alt valor ecològic.

5.2. ALTERNATIVA 2. INSTAL·LACIÓ DE SENSORS DE MESURA DE CABALS

Una segona alternativa amb menor impacte ambiental i tècnicament viable, és la instal·lació de sensors no invasius a les estructures hidràuliques existents al pas de les rieres sota la xarxa viària. Aquests dispositius permeten mesurar el nivell de la làmina d'aigua i la velocitat del flux. Mitjançant el processament d'ambdues dades juntament amb la geometria de l'estructura, es pot calcular el cabal amb precisió per a les finalitats de seguiment hidrològic.

A la riera Gran de Lió, la riera de Can Morgat i la riera Castellana, aquesta opció no requereix actuacions sobre el llit del rec o riera, preserva les condicions naturals del medi fluvial i redueix notablement tant els costos d'implantació com l'impacte ambiental de la instal·lació.

En el cas del rec de la Llacuna dels Amaradors i la riera dels Tenyers, que presenten unes dimensions reduïdes, no és viable la instal·lació del sensor en una estructura hidràulica ja existent. Per aquest motiu, en ambdós cursos es formaria un tram de llera amb secció coneguda, dissenyat expressament per a la col·locació del sensor, sense reduir la secció de la llera (que si es reduiria amb els canals Parshall). Aquest tram canalitzat es construiria immediatament a continuació d'estructures ja existents, amb l'objectiu de minimitzar l'impacte sobre la morfologia natural de la riera.

5.3. ALTERNATIVES PER A L'ALIMENTACIÓ DE LES INSTAL·LACIONS

L'escomesa elèctrica per al funcionament dels punts de mesura ha de preveure l'alimentació del sensor i datalogger instal·lats en cada punt. Donada la situació dels punts de mesura lluny d'escomeses connectades a la xarxa elèctrica, cal recórrer a instal·lacions autònomes.

Per un altre costat, els requeriments elèctrics del sensor i del datalogger són massa elevats per a un ús en continu sense alimentació directa de la xarxa. Alimentar de forma autònoma cada punt per al funcionament en continu implicaria un sobredimensionament de les plaques solars i bateries que es considera innecessari. L'alternativa és la presa de mesures a certs intervals i la transmissió de dades un o dos cops al dia. A aquestes dades preses automàticament es poden afegir dades preses sobre demanda manual.

Amb aquest patró de presa i enviament de dades es poden dimensionar els sistemes d'alimentació amb una despesa raonable. Es consideren dues solucions principals:

- Alternativa A: Alimentació mitjançant panells solars fotovoltaics. Es proposa la instal·lació d'un kit solar amb un panell de 50 W per a cada instal·lació (cabalímetre i datalogger), que permetria autonomia energètica. No obstant això, les condicions d'insolació a les ubicacions seleccionades per als cabalímetres són insuficients per garantir una captació energètica adequada de forma continuada, especialment donat l'ombrejament per vegetació existent.
- Alternativa B: Alimentació mitjançant bateries recarregables. Aquesta opció consisteix en l'ús de bateries de 100 Ah i 12 V, amb una autonomia estimada d'un mes per al patró d'ús indicat en el paràgraf precedent. Una autonomia mensual permet una gestió operativa eficient a través de manteniments mensuals programats per a la recàrrega o substitució de les bateries.

5.4. ALTERNATIVA ESCOLLIDA

Després d'analitzar les dues opcions tècniques plantejades, s'ha optat per l'alternativa 2: instal·lació de sensors de mesura de cabals, com a solució principal per al conjunt dels punts d'aforament previstos.

Aquesta decisió es fonamenta en criteris de sostenibilitat ambiental, viabilitat tècnica i eficiència econòmica. Els sensors de cabal, que operen mitjançant la mesura del nivell i la velocitat de l'aigua en estructures existents, permeten una implantació mínimament invasiva, compatible amb la conservació de la morfologia fluvial i la vegetació de ribera. Aquesta solució és especialment adequada en entorns sensibles i lleres grans, on la instal·lació de canals Parshall implicaria una alteració substancial del llit i un impacte ecològic important.

Així mateix, aquesta alternativa permet aprofitar les infraestructures existents (estructures de pas viàries), reduint significativament l'envergadura de les actuacions i, per tant, els costos i terminis d'execució. En els cursos de menor dimensió com el rec de la Llacuna dels Amaradors i la riera dels Tenyers, es preveu la creació d'un tram de llera amb secció coneguda específicament per a la instal·lació dels sensors, assegurant així la precisió de la mesura sense comprometre la capacitat de desguàs ni alterar de manera substancial la dinàmica natural del curs d'aigua.

Pel que fa a l'alimentació, es proposa instal·lar bateries de 150Ah 12V a totes les instal·lacions. El motiu és que tots els punts d'instal·lació dels cabalímetres manquen d'insolació suficient per a l'alimentació amb placa solar. L'únic punt de l'àmbit amb suficient insolació és a la riera dels Tenyers, però en aquest punt s'ha de descartar per l'impacte visual de la columna i placa solar a la zona recuperada paisatgísticament de l'Església de Porqueres.

Aquesta combinació permet optimitzar els resultats del sistema d'aforament global a l'entorn de l'Estany de Banyoles, assegurant una cobertura adequada del monitoratge hidrològic amb una mínima alteració

del medi natural, d'acord amb els criteris del Consorci de l'Estany i les bones pràctiques en restauració i conservació ambiental.

6. DESCRIPCIÓ DELS ELEMENTS A SUBMINISTRAR

En aquest apartat es descriuen les característiques dels cabalímetres que s'instal·laran en els quatre cursos hídrics seleccionats, amb l'objectiu de mesurar les aportacions d'aigua a l'Estany de Banyoles i optimitzar la seva gestió hidràulica. Els elements a subministrar han estat escollits tenint en compte la singularitat ambiental de l'àmbit, la seva accessibilitat i la compatibilitat amb la normativa sectorial.

Cal també consultar els plànols 2 al 4 on es determina la ubicació de cada actuació i el detall de les mateixes.

Es garantirà que totes les actuacions:

- S'adaptin al marc legal del PEIN, Xarxa Natura 2000 i AIFF 1299.
- No alterin la vegetació de ribera ni els hàbitats d'interès.
- Evitin l'afectació a l'espècie *Carex elata* subsp. *elata,* present a l'àmbit.
- Tinguin un impacte visual mínim mitjançant disseny discret i materials naturals o camuflats.

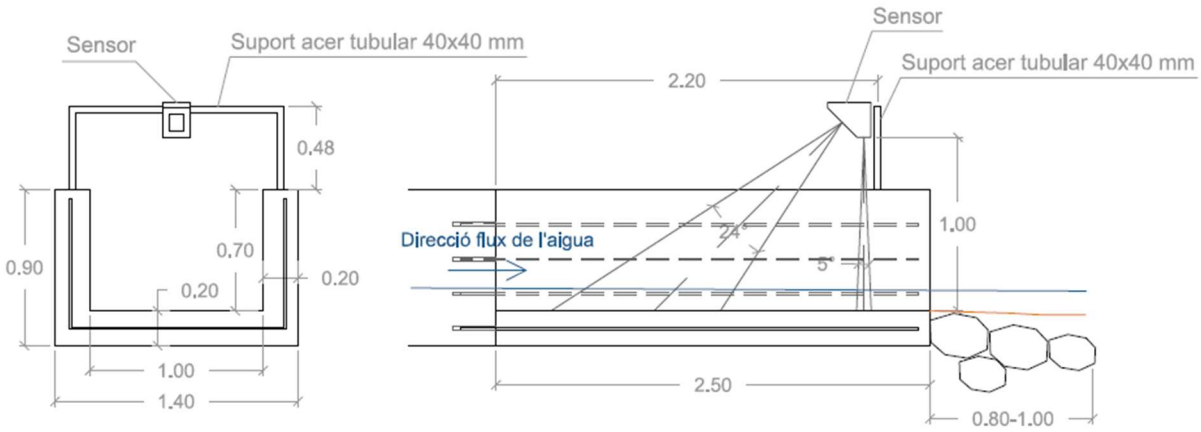
6.1. ADAPTACIÓ DEL CANAL A LA RIERA DELS TENYERS I EL REC A LA LLACUNA DELS AMARADORS

En els punts de mesura de cabal al rec a la Llacuna dels Amaradors i a la riera dels Tenyers, no existeix una infraestructura hidràulica que permeti la mesura del cabal. Per aquest motiu es submnisitrarà un canal de formigó prefabricat de secció coneguda, amb les mateixes dimensions de la llera en aquell punt, i ancorat a estructures de formigó ja existents.

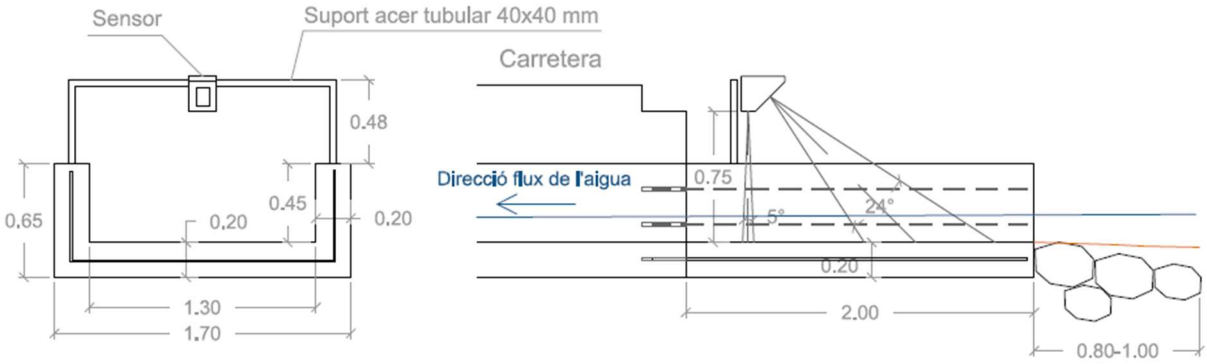
El canal serà de formigó armat i 20 cm de gruix tant a les parets com a la solera. S'armarà amb barra d'acer de 12 mm de diàmetre i s'ancorarà a les estructures de formigó existents mitjançant barra d'acer de 12 mm de diàmetre i resines epoxi o tac químic. A la sortida del canal aigües avall es col·locaran pedres d'escullera petita (100-400 kg) soltes (sense formigonar) per evitar l'erosió de la base de la llera. La longitud del tram canalitzat vindrà donada per la profunditat del mateix i l'alçada de la posició del radar per a una correcta mesura (veure imatges 13-14 i plànols).

- Al rec a la Llacuna dels Amaradors, el prefabricat de formigó farà 2,5 m de longitud, 1 m d'amplada de secció interior, i s'ancorarà als estreps de formigó del bagant existent, aigües avall del mateix.
- A la riera dels Tenyers, el prefabricat de formigó farà 2,20 m de longitud, 1,30 m d'amplada de secció interior, i s'ancorarà al marc de formigó del pas de la riera sota la carretera, al marge oest de la mateixa (no a la banda de l'Estany sinó a la banda terra endins).

Seccions canal al rec a la Llacuna dels Amaradors



Seccions canal a la riera dels Tenyers



Els elements a subministrar seran:

1. Prefabricat de formigó
2. Marc de suport dels sensors.
3. Armari estanc
4. Cabalímetre/datalogger i bateria.

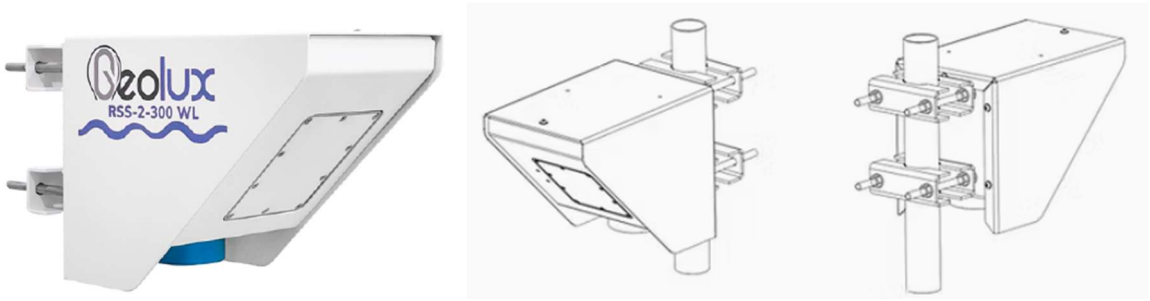
6.2. SENSORS EN ESTRUCTURES HIDRÀULIQUES

Per a mesurar el cabal al Rec Gran de Lió, rec a la Llacuna dels Amaradors, Riera de Can Morgat, Riera Castellana i Riera dels Tenyers es subministrarà un cabalímetre amb tecnologia radar de microones per mesura de nivell, la velocitat i el cabal de cada rec/riera. Aquesta tecnologia no es veu afectada per canvis de temperatura, vent o pluja, proporcionant mesures acurades sense afectació al medi.

El cabalímetre serà tipus radar de microones per a un rang de 0,2 m a 15 m, resolució del nivell d'aigua de 0,5 mm i resolució de velocitat de l'aigua 0,001 m/s, amb comunicació 4G - sistema RS-232/485, SDI-12 analògic, 4-20 mA, amb carcassa d'alumini anoditzat i temperatura de funcionament -40ºC a 85ºC, tipus Geolux RSS-2-300WL o **equivalent.**

Totes les característiques tècniques definides i que corresponen a marques comercials, només serveixen per a definir les característiques rquerides dels mateixos. **S'admetran altres marques amb característiques tècniques equivalent**

Cabalímetre radar de microones

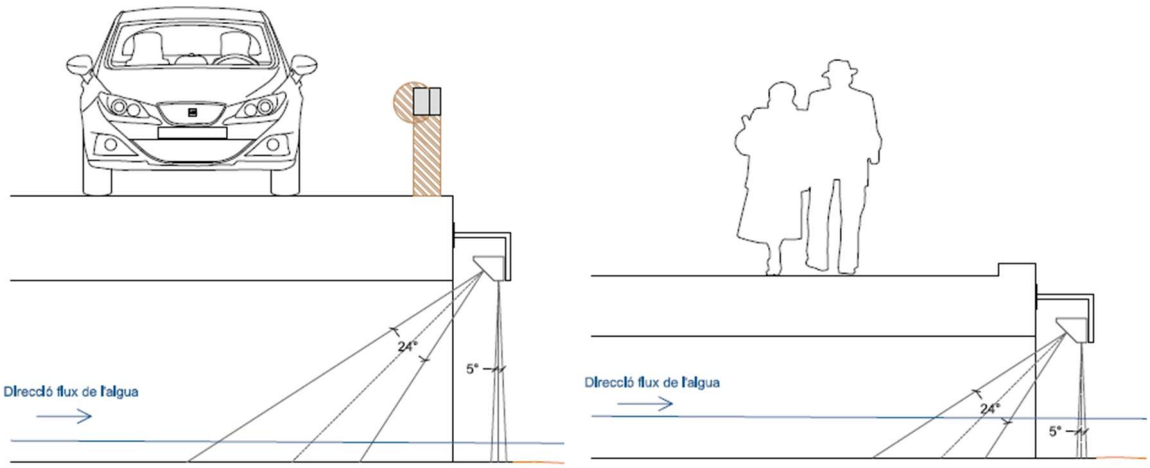


També s'haurà de subministrar:

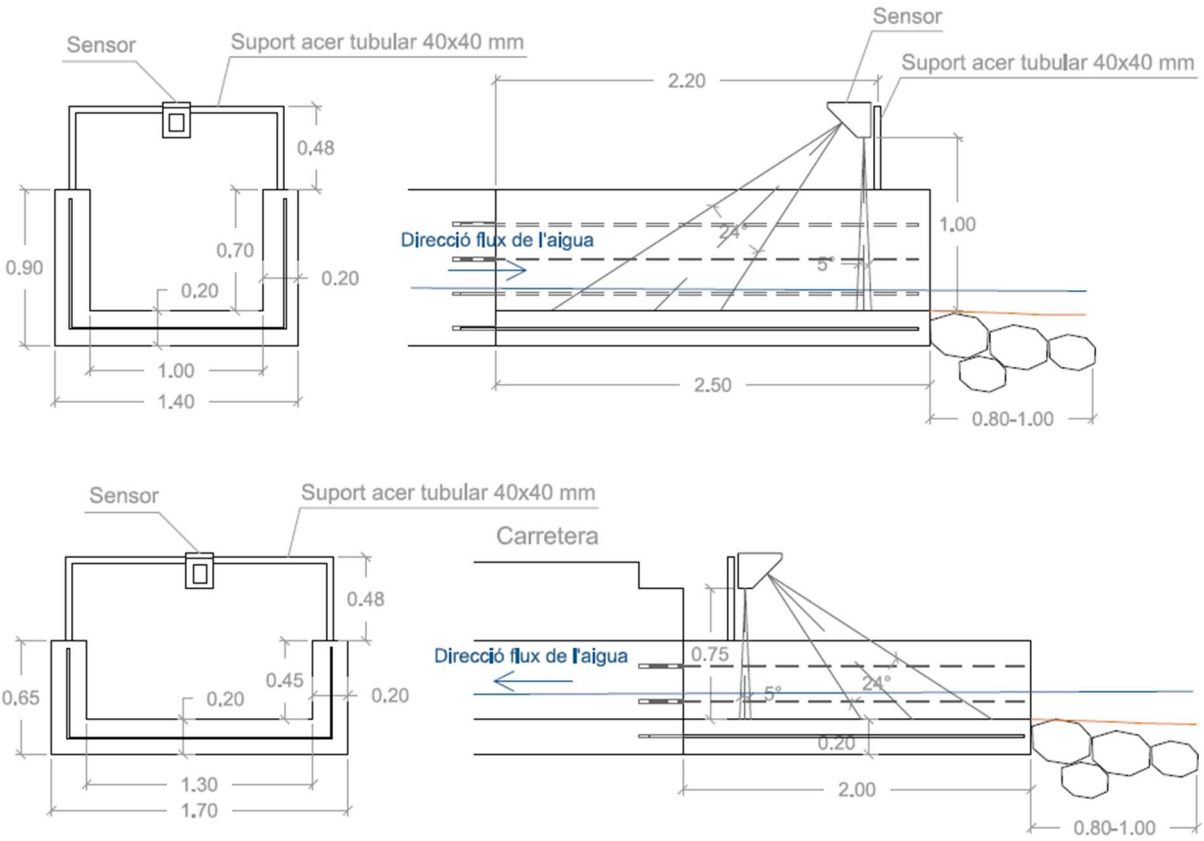
A les estructures hidràuliques, s'haurà de subministrar un braç d'acer tubular de 40x40 mm de secció, que s'ancorarà amb placa de 200x200 mm i cargols amb tac químic a la llinda de l'estructura per poder ancorar els sensors a la llinda de l'obra de fàbrica.

Als trams canalitzats, s'haurà de subministrar un arc de suport d'acer tubular de 40x40 mm, per encastar al formigó del canal i poder muntar els suports.

Ubicació dels sensors en estructures de pas sota camins i carreteres



Ubicació de sensor en tram canalitzat



6.3. SISTEMES D'ALIMENTACIÓ I TRANSMISSIÓ DE DADES

Transmissió de dades

Per a la recollida i transmissió de les dades mesurades pel cabalímetre (velocitat de l'aigua, profunditat de la làmina d'aigua i cabal calculat) s'utilitzarà un datalogger tipus HD33[L]MT.4 **o equivalent** amb mòdul ETHERNET per a la transmissió de dades via 4G, amb protocols de transmissió de dades MODBUS-RTU, HTTP, FTP i correu electrònic; senyals d'entrada analògiques i digitals, RS-485 i SDI-12; senyals de sortida RS-485, USB i 4G.

Les dades seran recollides per una plataforma de monitorització online Weathercloud, amb subscripció anual. Aquesta és la opció recollida al pressupost per a l'accés immediat a les dades. Aquesta aplicació també permetrà veure el nivell de la bateria en cada punt, amb indicació del moment que cal canviar-les.

Totes les característiques tècniques definides i que corresponen a marques comercials, només serveixen per a definir les característiques requerides pels mateixos. **S'admetran altres marques amb característiques tècniques equivalent**

Sistema d'alimentació

La font d'alimentació del sistema conjunt de sensor i datalogger serà una bateria recarregable de 150 Ah, de 12V per a una durada aproximada de 1,5 mesos, donat que no hi ha insolació suficient per a la instal·lació de placa solar.

El nivell de les bateries es podrà monitoritzar a la plataforma de recull i seguiment de dades, que també indicarà quan sigui necessari canviar-les (recarregades).

La bateria s'ubicarà a l'armari prefabricat situat a les proximitats de la instal·lació (veure punt 6.4.).

6.4. ARMARI PER ALLOTJAR BATERIA I DATALOGGER

Per tal d'allotjar el datalogger i la bateria es subministraran armaris de formigó prefabricat de 850x680x330 mm per a servei exterior, porta de xapa d'acer de 500x600 mm amb escletxes per a ventilació i pany anti vandalisme.

Armari prefabricat formigó

7. TERMINIS

Els termini d'entrega dels materials és de 6 setmanes.

8. REVISIÓ DE PREUS

El subministrament dels cabalímetres té una durada inferior a 12 mesos, i per tant no cal revisió de preus segons la legislació vigent.

9. PRESSUPOST

MATERIALS ACCESORIS ..... 2.535,46 €
ARMARIS ..... 2.527,20 €
SENSORS I DATALOGGERS ..... 38.947,81 €
ALIMENTACIÓ ELÈCTRICA ..... 4.214.82 €

Subtotal ..... 48.225,29 €
21% IVA sobre 48.225,29 € ..... 10.127,31 €

TOTAL PRESSUPOST ..... 58.352,60 €

El pressupost del subministrament puja a la quantitat de CINQUANTA-VUIT MIL TRES-CENTS CINQUANTA-DOS EUROS AMB SEIXANTA CÈNTIMS (58.352,60 €).

10. DOCUMENTS

DOCUMENT 1: MEMÒRIA I ANNEXOS

MEMÒRIA

ANNEXOS

Annex núm. 1. Cabalímetres. Documentació

Annex núm. 2. Datalogger. Documentació

Annex núm. 2. Armari de formigó. Documentació

NOTA: Totes les característiques tècniques definides en els següents annexes, i que corresponen a marques comercials, només serveixen per a definir les característiques dels mateixos. **S'admetran altres marques amb característiques tècniques equivalents**.

DOCUMENT 2: PLÀNOLS

Plànol núm. 1. Situació

Plànol núm. 2. Emplaçament

Plànol núm. 3. Sensors en estructures hidràuliques

Plànol núm. 4. Sensors en tram canalitzat

DOCUMENT 3: PRESSUPOST

Amidaments

Pressupost

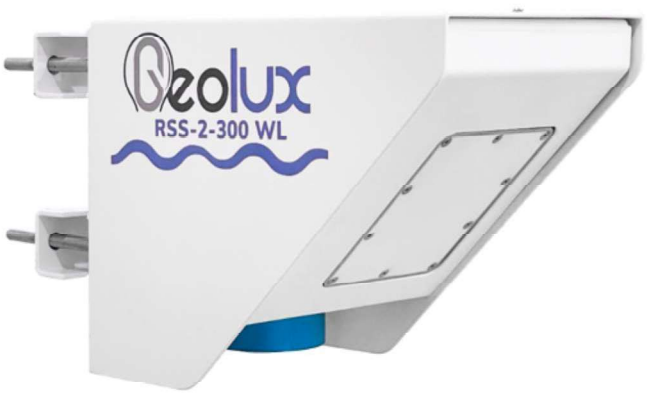
Resum de pressupost

Últim full

ANNEX NÚM. 1

CABALÍMETRE. DOCUMENTACIÓ

Finançat per
Unió Europea
Fons Europeu
Next Generation
GOBIERNO DE ESPAÑA
Pla de Recuperació, Transformació i Resiliència
Next Generation Catalunya
Generalitat de Catalunya



Caudalímetro Radar

Utiliza tecnología radar de microondas para proporcionar mediciones precisas y fiables del nivel, la velocidad y el caudal de agua bajo cualquier condición meteorológica. Es idóneo para todo tipo de aplicaciones hidrológicas y de alerta temprana en ríos, lagos, embalses, presas, puertos, etc.

SKU: RSS-2-300WL Categoría: Sensores de Nivel de Agua

Descripción

Mediciones precisas y fiables

El medidor utiliza tecnología radar de microondas para proporcionar mediciones precisas y fiables del nivel, la velocidad y el caudal de agua bajo cualquier condición meteorológica. Esta tecnología no se ve afectada por cambios de temperatura, viento o lluvia, así como tampoco por condiciones de niebla o rocío, a diferencia de los sensores que emplean tecnología ultrasónica.

El medidor puede configurarse para llevar a cabo un filtrado y promediado digital de las mediciones según las necesidades específicas del usuario, y calcula la descarga de agua de un río, canal o arroyo en función del perfil de la sección transversal definido en el software de configuración. Se puede conectar a cualquier datalogger convencional para llevar a cabo el almacenamiento de los datos y su posterior descarga y visualización en un ordenador. Su reducido consumo permite utilizarlo en instalaciones alimentadas mediante paneles solares.

Idóneo para aplicaciones hidrológicas y de alerta temprana

El instrumento presenta un diseño compacto y sin partes móviles, y está fabricado íntegramente en aluminio anodizado para garantizar una alta resistencia en entornos marinos. Asimismo, no requiere prácticamente mantenimiento al no estar directamente expuesto al agua como ocurre con los sensores sumergidos.

Es idóneo para todo tipo de aplicaciones hidrológicas y de alerta temprana en ríos, lagos, embalses, presas, puertos, etc.

Especificaciones técnicas

Especificaciones del sensor

Nivel de agua

- Rango: 0,2 a 15/30 m
- Resolución: 0,5 mm
- Precisión: ±2 mm

Velocidad del agua

- Rango: 0,02 a 15 m/s
- Resolución: 0,001 m/s
- Precisión: ±1%

Especificaciones eléctricas

- Voltaje de alimentación: 9 a 27 VDC
- Consumo: 750 mA (máx.)
- Señal de salida: 4 a 20 mA, RS-232, RS-485 y SDI-12

Especificaciones mecánicas

- Temperatura de funcionamiento: -40°C a 85°C
- Material: aluminio anodizado
- Dimensiones: 250 x 200 x 150 mm
- Peso: 3,1 Kg

RSS-2-300WL Flow Meter

HIGH-PRECISION NON-CONTACT OPEN CHANNEL FLOW VELOCITY & LEVEL METER

Highlights

- Contactless flow measurement and surface velocity measurement
- Integrated discharge (flow) calculation
- RS-232, RS-485 Modbus, SDI-12, and analog 4-20 mA interfaces in all models
- Remote configuration of all instrument parameters through any digital communication interface
- Robust IP68 aluminum or stainless steel enclosure

Applications

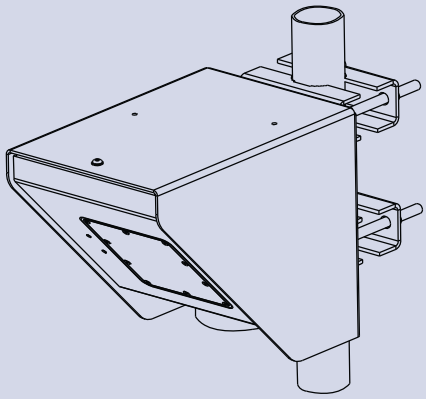
- Early flood warning
- Monitoring of flow and irrigation channels
- Accurate discharge monitoring in rivers
- Flow tracking in salt and copper mine channels
- Sewage and waste water discharge measurement

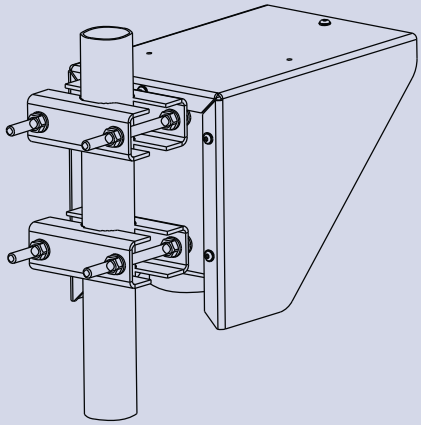
Product Description

The Geolux RSS-2-300WL has an integrated radar surface velocity and level meter for contactless measurements of surface flow velocity and water level. Contactless radar technology enables quick and simple sensor installation above the water surface with minimum maintenance.

Calculation of the total flow discharge is internally implemented within the instrument by combining surface velocity measurement, water level measurement, and a configured cross-section of the river or channel. Defining the measurement parameters such as profile cross-section, material of the edges, location of the sensor above the water, and all other instrument settings can be easily set with the Geolux configuration application using any available communication interface.

Detailed Specifications





Detection Distance	15 m / 30 m / 35 m
Speed Range	0.02 m/s to 15 m/s / 0.02 m/s to 16 m/s
Speed Resolution	0.001 m/s
Speed Accuracy	1%
Level Resolution	0.5 mm
Level Accuracy	± 2 mm
Velocity Sensor Beam Width	Azimuth: 12° Elevation: 24°
Level Sensor Beam Width	Azimuth: 5° (± 2.5°) Elevation: 5° (± 2.5°)
Sampling Frequency	1 sps / 10 sps optional
IP Rating	IP68
Serial Interface	1 x serial RS-485 half-duplex 1 x serial RS-232 (two wire interface)
Serial Baud Rate	9600 bps to 115200 bps
Serial Protocols	GLX-NMEA, Modbus
Other Protocols	SDI-12
Analog Output	4-20 mA, programmable velocity, level or flow
Input Voltage	9 to 27 VDC
Power Consumption	1.3 W operational; 0.235 W standby
Maximal Current	< 750 mA
Temperature Range	-40 °C to +85 °C (without heating or coolers)
Enclosure Dimensions	150 mm x 200 mm x 250 mm

FCC & CE ***APPROVED***

MADE IN ***EU***

For more information, contact us:

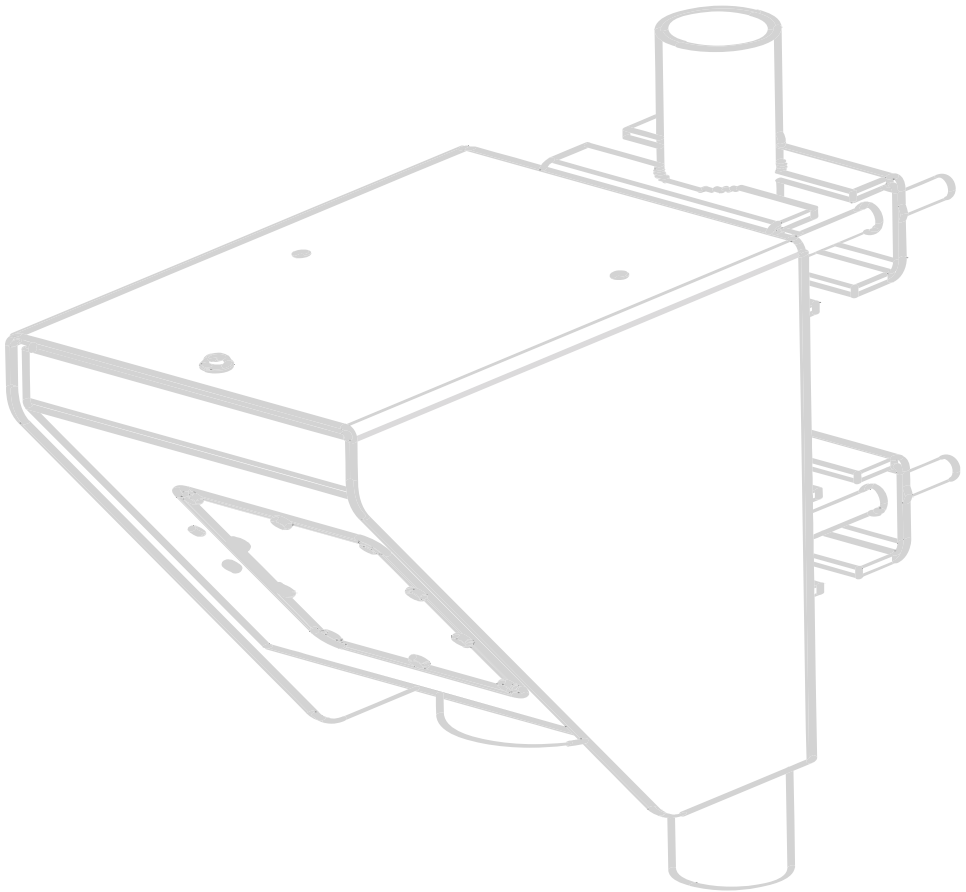
www.geolux-radars.com

RSS-2-300WL

Non-Contact Flow Meter

User Manual

v6.7.9



Starting Point

Thank you for purchasing Geolux RSS-2-300WL non-contact open channel flow meter! We have put together the experience of our engineers, the domain knowledge of our customers, the enthusiasm of our team, and the manufacturing excellence to deliver this product to you.

You may freely rely on our field-proven radar technology. The use of top-quality components and advanced signal processing algorithms ensures that Geolux level meter can be used in various applications and environments.

We have created this User Manual to assist you in setting up and using the Geolux instrument.

Should there be any questions left unanswered, please feel free to contact us directly:

Contents

1 Introduction

Geolux RSS-2-300WL flow meter uses radar technology to provide precise contactless measurement of surface flow velocity and precise distance (level) measurement from the sensor to the water surface. Fully contactless radar technology enables quick and simple sensor installation above the water surface and requires minimum maintenance.

Surface velocity measurement functionality is achieved by transmitting an electromagnetic wave in 24 GHz frequency range (K-band) and measuring the frequency shift of the electromagnetic wave reflected from the flowing water surface. The frequency shift is caused by the Doppler effect of the moving surface on the electromagnetic wave. As the relative speed between the radar sensor and the water surface increases, the detected frequency shift also increases, thus enabling the flow meter to precisely determine the surface velocity.

Water level is measured by measuring the distance from the sensor to the water surface, which is proportional to the frequency difference between the transmitted and the received signal. The radar periodically transmits a linear chirp ranging in frequency from 77 GHz to 81 GHz. As the distance between the radar and the water surface increases, so does the difference between the transmitted and received frequency, enabling the level meter to precisely determine the distance between the sensor and the water surface. The radio signal modulation and detection algorithms used in the sensor allow very precise measurements that are not dependent on air temperature, humidity, or other parameters of the environment.

The flow meter is able to detect water surface velocity ranging from 0.02 m/s to 15.0 m/s with precision of 0.001 m/s while the distance can be measured in range from 0.2 m to 15 m or 30 m with resolution of 0.5 mm and accuracy of ±2 mm. An integrated tilt sensor measures the inclination angle of the sensors and the surface velocity measurement is automatically cosine-corrected according to the measured mounting tilt angle.

The flow meter is able to measure water flow at distances ranging from 0.2 m up to either 15 m or 30 m, depending on the device version: WL-15-1 is the 15 m version of the device, and WL-30-1 is the 30 m version.

Calculation of the flow (discharge) is done internally in the sensor combining surface velocity measurement and level measurement with configured cross section of the river or channel. Configuration of the measurement parameters like channel profile cross section, material of the edges and the location of the sensor above the water can be easily set using Geolux PC configuration application - Geolux Instrument Configurator. When parameters are set properly, the sensor will calculate flow with an accuracy of approximately ±1% compared to ADCP measurement for the same location. Measurements of the surface velocity and water level will also be available in parallel to the flow readings on the sensor digital communication interfaces.

2 Electrical Characteristics

The electrical characteristics of the Geolux RSS-2-300WL flow meter are given in Table 1.

Table 1. Electrical Characteristics

Parameter	MIN	TYP	MAX	Unit
Communication interface: RS-232 interface speed RS-485 interface speed	 1200 1200		 115200 115200	 bps bps
Radar Velocity Sensor Frequency Radiated power (EIRP) Sensitivity Beam-width (3dB) – Azimuth Beam-width (3dB) – Elevation Measurement range Resolution Accuracy Installation height above the water	 24.075 -108 0.02 0.001 	 24.125 -110 12 24 1 	 24.175 20 -112 15.0 15	 GHz dBm dBm ° ° m/s m/s % m
Radar Level Sensor Frequency Beam-width (3dB) – Azimuth Beam-width (3dB) – Elevation Resolution Accuracy Minimal distance Maximal distance	 77.000 0.5 0.2 	 5 (±2.5) 5 (±2.5) 2 	 81.000 15/30	 GHz ° ° mm mm m m
Power supply voltage	9.0	12.0	27.0	V
Power Operational mode Sleep mode		 1550 85		 mW mW
Alarm Output Maximal Current			60	mA
Alarm Output Maximal Voltage			30	VDC
Analog Output Maximal Voltage			30	VDC
Operational Temperature Range	-40		+85	°C
Angle Compensation	0	30	75	deg.
Installation Height Above the Water	0.2		15/30	m
Sample rate Level and Discharge Velocity		 1 10		 sps sps
Ingress Protection Rating	IP68			
Mechanical		150x200x250		mm

FCC and ISED Canada Regulatory Compliance

FCC ID: 2AN9X-RSS2300WL; IC: 26475-RSS2300WL

FCC

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

ISED Canada

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:
(1) This device may not cause interference.
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil contient des émetteurs/récepteurs exempts de licence qui sont conformes aux RSS exemptes de licence d'Innovation, Sciences et Développement économique Canada. Son fonctionnement est soumis aux deux conditions suivantes:
(1) Cet appareil ne doit pas provoquer d'interférences.
(2) Cet appareil doit accepter toutes les interférences, y compris les interférences susceptibles d'entraîner un fonctionnement indésir-able de l'appareil.

RSS-Gen compliance requires:

(i) The installation of the LPR/TLPR device shall be done by trained installers, in strict compliance with the manufacturer's instructions.
(ii) The use of this device is on a "no-interference, no-protection" basis. That is, the user shall accept operations of high-powered radar in the same frequency band which may interfere with or damage this device. However, devices found to interfere with primary licensing operations will be required to be removed at the user's expense.
(iii) The installer/user of this device shall ensure that it is at least 10 km from the Dominion Astrophysical Radio Observatory (DRAO) near Penticton, British Columbia. The coordinates of the DRAO are latitude 49°19'15'' N and longitude 119°37'12'' W. For devices not meeting this 10 km separation (e.g., those in the Okanagan Valley, British Columbia,) the installer/user must coordinate with, and obtain the written concurrence of, the Director of the DRAO before the equipment can be installed or operated. The Director of the DRAO may be contacted at 250-497-2300 (tel.) or 250-497-2355 (fax). (Alternatively, the Manager, Regulatory Standards, Industry Canada, may be contacted.)

RF Exposure Notice

In order to comply with FCC and ISED Canada RF Exposure requirements, a minimum separation distance of 20 cm must be maintained between the device and all persons during normal operation.

Afin de se conformer aux exigences de la FCC et de l'ISED en matière d'exposition aux RF, une distance de séparation minimale de 20 cm doit être maintenue entre l'appareil et toutes les personnes pendant le fonctionnement normal.

3 Cable Pin-Out

The flow meter is supplied with open end cable consisting of 12 wires coded with colours. Table 2 gives a detailed description for each wire.

It is possible to mount optional connectors on the cable end per user request. In this case, the connector specification and connection diagram must be specified when ordering the sensor.

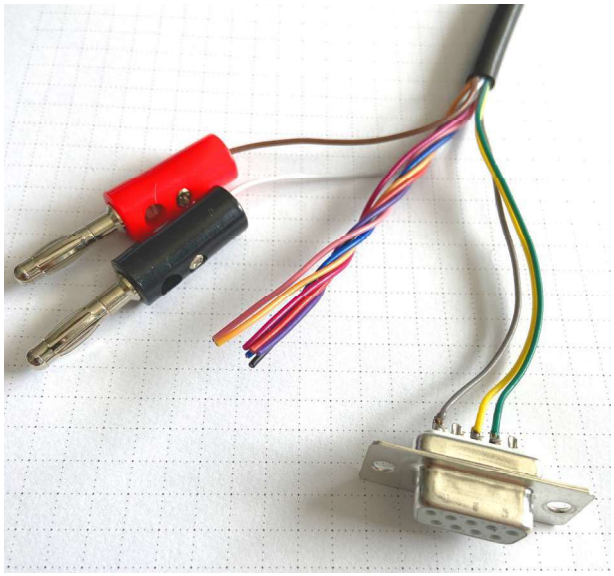
Table 2. Cable Pin-Out

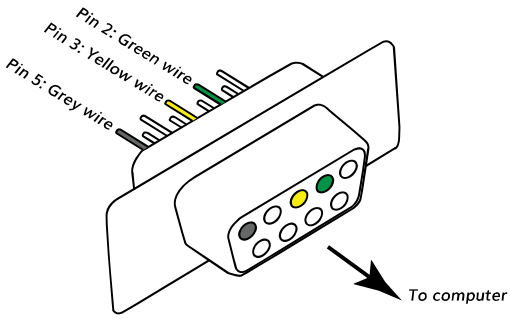
Pin No.	Wire Color		Pin Name	Pin Description
1	White		GND	This pin should be connected to the ground (negative) pole of the power supply.
2	Brown		+Vin	The power supply for the Radar Speed Sensor is provided on this pin. The Radar Speed Sensor power supply voltage must be in the range of 9 VDC to 27 VDC, and the power supply must be able to provide at last 0.65W
3	Green		RS232 – TxD	RS-232 data transmit signal.
4	Yellow		RS232 – RxD	RS-232 data receive signal.
5	Grey		GND	Signal ground.
6	Pink		CAN – H	CAN2.0B high signal. (optional)
7	Blue		CAN – L	CAN2.0B low signal. (optional)
8	Red		SDI12 DATA	SDI12 data line
9	Orange		RS485 – D-	RS-485 data transmitter/receiver low signal.
10	Dark Red		RS485 – D+	RS-485 data transmitter/receiver high signal.
11	Black		Alarm SW or 4–20 mA Secondary (Optional)	Alarm 1 - open collector switch signal max. 60mA
12	Purple		4 – 20 mA	Sink for 4 – 20 mA analog interface. Connect sensing device as pull-up to sink the current

3.1. Serial RS-232 Interface

Serial RS-232 interface is implemented as standard PC full-duplex serial interface with voltage levels adequate for direct connection to PC computer or other embedded devices used for serial RS-232 communication.

In case the RS-232 interface is connected to standard DB-9 PC connector, TxD line (green wire) is connected to pin 2 and RxD (yellow wire) is connected to pin 3. For proper operation of the serial interface, additional connection of signal GND (grey wire) is required on pin 5 of the DB-9 connector.





Picture 1. Serial RS232 DB-9 Cable

Geolux recommends using Waveshare USB TO RS232/485/TTL converter for connecting Geolux instruments to computers without a native RS-232 port.

https://www.waveshare.com/catalog/product/view/id/3629/s/usb-to-rs232-485-ttl/category/37/

Optionally Geolux can supply a cable with DB-9 connector connected to the cable but this must be specified as option when ordering the sensors.

Several communication protocols are available, and custom on request. Details of communication protocols are described later in this user manual.

3.2. Serial RS-485 Interface

Serial RS-485 interface is implemented as standard industrial half-duplex communication interface. Communication interface is internally protected from short-circuiting and overvoltage. Depending on the receiving device, the interface can be used with only two wires (D+ dark red wire & D- orange wire) while in some cases ground connection (signal GND gray wire) is also required. For more details, please consult receiver specification.

The most common communication protocol used with RS-485 interface is Modbus-RTU but other protocols are also available. Details of communication protocols are described in chapter 7 of this user manual.

3.3. CAN Communication Interface (Optional)

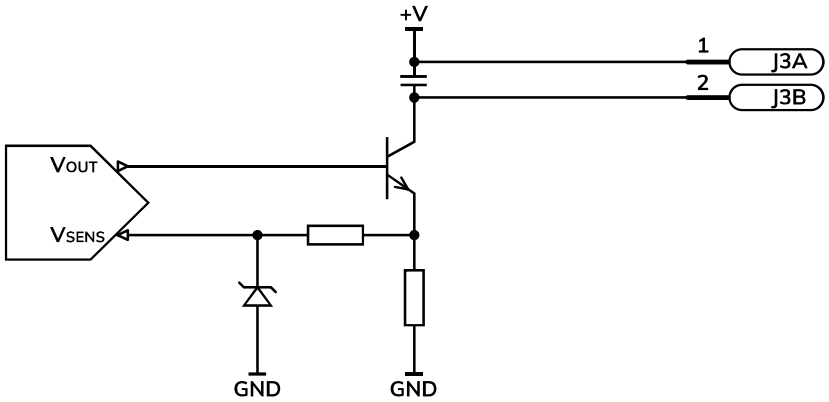
CAN communication interface is an optional communication interface that can be used for special applications. This interface is a higher speed interface (up to 1 Mbps) than other serial communication interfaces, thus enabling additional data transfer which would otherwise not be possible with RS-232 and RS-485 interfaces.

CAN interface is disabled in the default sensor version - for additional features using CAN interface please contact technical support.

3.4. Analog 4 – 20 mA Output

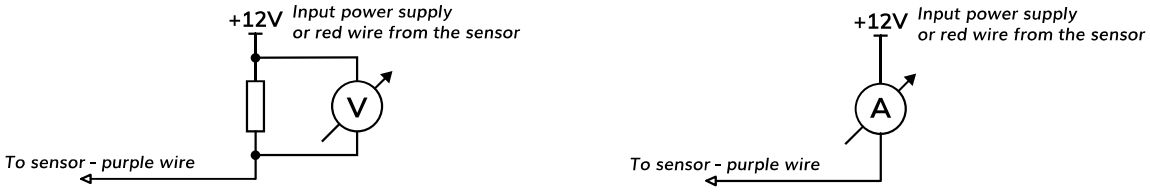
Analog current 4 – 20 mA output is provided for easier compatibility with older logging and control systems. Output is implemented as current sink architecture with common ground. Maximal voltage applied to the sink can go up to 30 VDC, providing greater flexibility in connections of the sensor to PLCs, loggers, or data concentrators.

Signal range and function for 4 – 20 mA analog output can be configured in the setup application so the sensor will be able to signal the best suitable value range with available current range. Current step in the sensor is 0.3 µA, which limits the resolution, so care has to be taken while setting the minimal value to be represented by 4 mA and the maximal value to be represented by 20 mA so the resolution is sufficient for the system requirements.



Picture 2. Analog 4 – 20 mA Output Internal Architecture

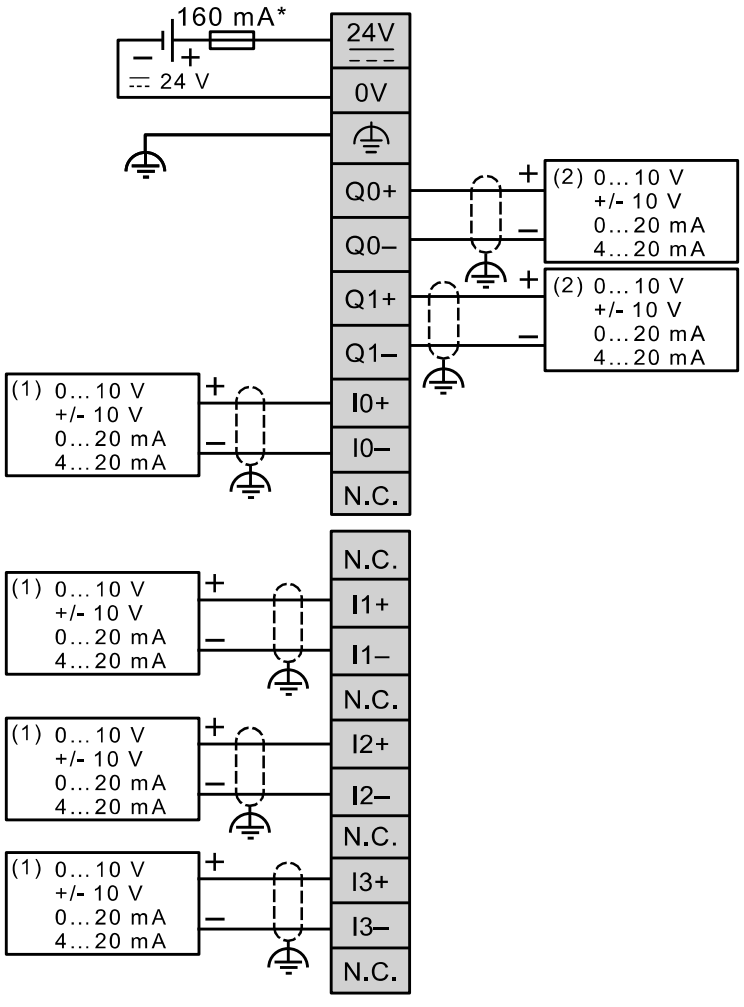
Measurement of the current by the client device (logger, PLC, modem etc.) must be implemented as the high side current measurement as shown in Picture 3. If a sensing resistor is used, resistance should be selected from the range of 10 Ω up to 500 Ω with a recommended value of 100 Ω for the sensing resistor.



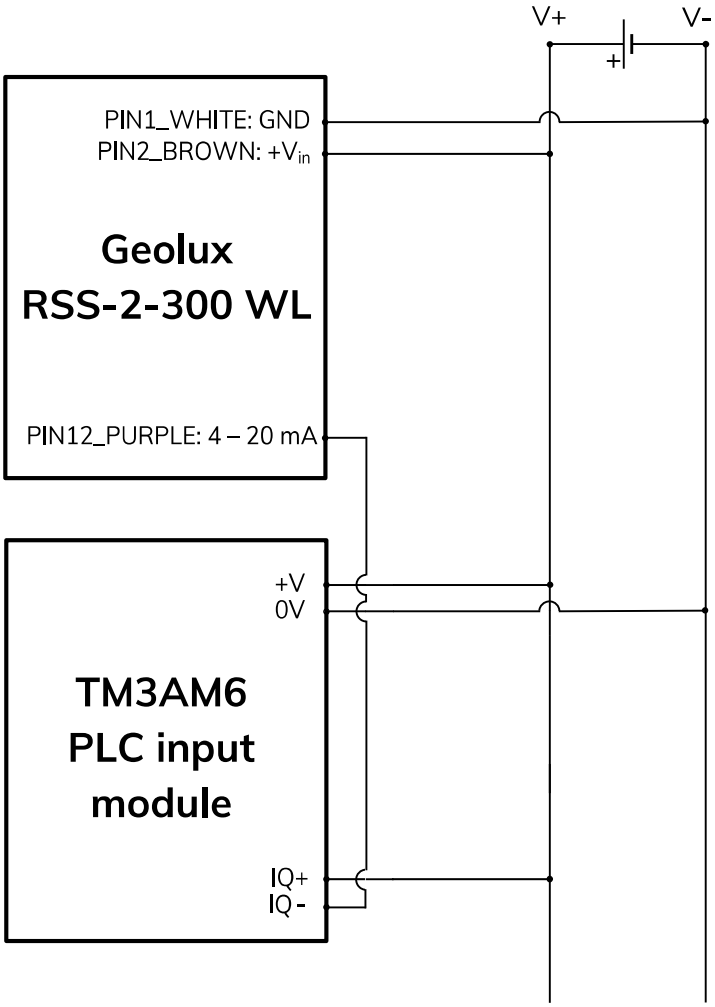
Picture 3. High Side Current Measurement for the 4 – 20 mA Analog Output

3.4.1. Connection to Schneider TM3AM6 analog input module

The TM3AM6 analog module contains 4 analog inputs, marked I0 to I3. Each analog input consists of two connectors, marked as I+ and I-. Each analog input can be configured to work either as analog voltage input (0 – 10 V or -10 to +10 V), or as analog current input (0 – 20 mA or 4 – 20 mA). This is the wiring diagram from the TM3AM6 user manual:



In order to connect the Geolux instrument to the TM3AM6 module, the first step is to configure the selected input port as analog current input operating on 4 – 20 mA range. This is done by using Schneider software. After the analog input module is configured, the second step is to connect the Geolux instrument to the TM3AM6 module, according to the following schematic diagram:



It is important to note that the 4 – 20 mA wire from the Geolux instrument should be connected to negative (-), not positive (+) terminal of the analog input port.

3.5. SDI-12 Interface

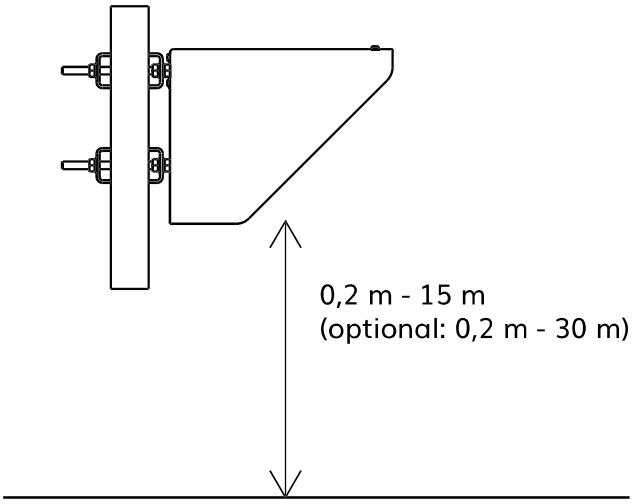
SDI-12 interface is widely used to connect hydrological equipment to dataloggers. SDI-12 uses a single communication line, and very slow speed communication to enable the use of very long communication cables.

For hydrological applications, SDI-12 communication interface is a valid option and the instrument is natively able to communicate directly with SDI-12 master devices (dataloggers etc.).

4 Installing the Flow Meter

The flow meter must be installed above the water surface, pointing toward the water surface at a vertical angle. The minimum height above the water surface is 0.2 metres and it is recommended to mount the sensor 0.5 metres above the water or higher, with a maximum height up to 15 or 30 metres, depending on the device version. The instrument should be mounted on the vertical pole with inclination tolerance of ±3° to vertical plane reference.

Picture 4 shows how the radar should be positioned relative to the water surface.



Picture 4. Installing the Flow Meter

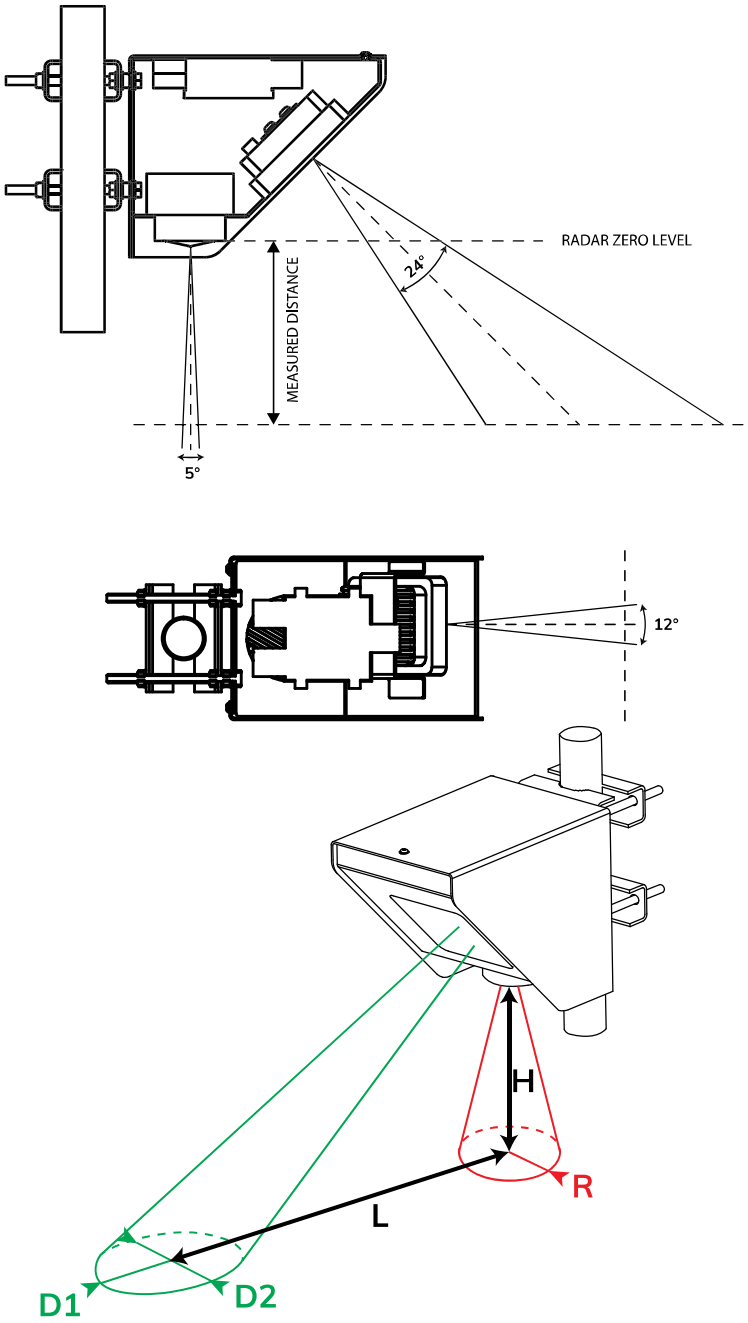
When mounting the instrument, special care must be taken to ensure that a direct line to the water surface is available and not obstructed for both the surface velocity and water level sensor. Any close objects in the vicinity of the sensor can reduce accuracy and introduce offsets in measurements. The best practice is to have a zone of 1 metre around both sensors clear of any other objects or structures.

4.1. Instrument Mounting and Location Selection

To achieve the specified accuracy, it is important to properly select the measurement site and to install the sensor with proper horizontal and vertical tilt angle. For optimal operation and best results, the instrument should be oriented in parallel with the water flow direction. Any deviation from parallel water flow direction will introduce offsets of the real measurement value, more precisely the value will be lower than the actual surface velocity of the water. It is recommended that the instrument is pointed upstream, so that the water flows towards the instrument.

The height of the instrument above the water surface and the inclination determine the area on the surface that is covered by the radar beam. This measurement area should be clear of any obstacles. The structure holding the instrument (pole, bridge fence, etc.) must be solid and without vibrations. There should be no vegetation between the radar and the measurement area because it could affect measurement accuracy. Water surface directly below the sensor should be void of vegetation, rocks, sand deposition or other obstacles that could affect measurement.

The surface velocity radar beam will cover an elliptical area on the water surface. The radar reports the average surface velocity of the covered area and uses complex Kalman filters with physical modeling of the water flow to give stable measurements even under turbulent conditions. However even the moderate waviness of the water surface will improve the measurement, if the water flow is strongly turbulent, fluctuations in measured data could be expected as well as somewhat reduced measurement accuracy. If strongly turbulent flow can be expected at monitoring site, then the filter length of the radar should be configured to 120 or more.



Picture 5. Radar Beam Widths and Coverage Areas

Height [H]	L [m]	D1 [m]	D2 [m]	R [m]
0.3 m	0.3	0.3	0.2	0.03
0.5 m	0.5	0.5	0.3	0.04
1 m	1.0	0.9	0.3	0.09
2 m	2.0	1.8	0.6	0.17
3 m	3.0	2.7	0.9	0.26
4 m	4.0	3.6	1.2	0.35
5 m	5.0	4.5	1.5	0.44
6 m	6.0	5.3	1.8	0.52
7 m	7.0	6.2	2.1	0.61
8 m	8.0	7.1	2.4	0.70
9 m	9.0	8.0	2.7	0.79
10 m	10.0	8.9	3.0	0.87
11 m	11.0	9.8	3.3	0.96
12 m	12.0	10.7	3.6	1.05
13 m	13.0	11.6	3.9	1.14
14 m	14.0	12.5	4.2	1.22
15 m	15.0	13.4	4.5	1.31

Lengths and diameters are calculated based on 3 dB signal drop (half signal power) due to the antenna pattern. For practical application the impact is that most of the return energy is reflected from the inside of the bounding shapes, ellipse for surface velocity sensor and circle for level sensor, but some energy could also be received from objects outside from the bounding shapes. Objects outside of the bounding shape should be fairly big to cause problems with the measurements and additionally, the sensors have internally implemented special signal processing algorithms to filter such reflections. However, it is recommended to keep the zone around the target shape of the radars as clear as possible to get best measurement accuracy.

4.2. Measurement Quality Indicator

Geolux RSS-2-300WL instrument is constantly calculating various parameters of the signal in the signal processing algorithms and will continuously, along with measurement data, report the measurement quality. The quality indicator value ranges from 0 (best quality) to 3 (worst quality) and can be used to interpret the data in the analysis software with better understanding and confidence.

For example, when the radar is mounted on the railway bridge, one of common applications, the measurement quality will be very good most of the time, except when a train is passing due to the extensive vibrations. In this case the radar will still report measurements but the reported values could be quite wrong, and also the measurement quality indicator value will go up to a higher value. It is up to every user to interpret the quality indicator value for their application, but general recommendation is that measurements with quality indicator 3 cannot be trusted, value 2 could be questionable, and values 1 and 0 are very good and accurate.

4.3. Rain and Wind

Geolux RSS-2-300WL instrument has integrated internal software filters to filter out effects of rain, fog, or wind both for surface velocity and for radar distance sensor. These filters however have some limitations. Majority of measurement inaccuracies caused by environmental factors can be solved by proper sensor installation.

For rain and snow suppression, the most effective solution is to mount the radar in a way that it points upstream and the water flows towards the radar. As rain falls down and the radar is tilted downwards, rain droplets will move away from the radar, while the water flows towards the radar. The radar can then easily distinguish the water movement from rain movement. To further improve rain filtering, the radar should be configured to report only incoming direction of the water flow. In this case, the radar will completely ignore all movement with direction going away from the sensor.

Influence of the wind on the accuracy of measured data is, in most cases small and can be neglected. The only exception is strong wind as it will create surface waves that are traveling in different direction from the water flow which can affect surface measurement accuracy.

4.4. Interference and Multiple Radars

The surface velocity radar operates in K band, in the frequency range around 24.125 GHz. Frequency stability and phase noise of the internal oscillator is very good and is always trimmed in the factory to a precise central frequency but even with the best possible trimming and most stable oscillators it is very unlikely that two devices will be working on the exact same frequency to cause interference. Doppler frequency shift caused by water in speed range up to 15 m/s is measured in kHz frequency shift. As this frequency shift is relatively small in comparison to the central frequency, in most cases below 0.00005%, it would be required to keep the difference between central frequencies of two radars in the same range for interference to occur.

The distance measurement radar operates in W-band ranging from 77 GHz to 81 GHz with linear frequency modulation, modulating the signal continuously in the aforementioned frequency range. For interference between two or more sensors to occur, it would be required to keep their central frequencies very precise and, just like with the surface velocity radar, timing synchronization of radars should be kept in range of 25 ns to each other. Such synchronization is very complex to achieve so the interference probability between several radars on the same location is very small.

Similarly, as with interference from two or more surface velocity radars on the same location, it is very unlikely that other radiation sources in K band will also affect radar measurements. It is possible that some wideband radiation sources can introduce small and impulse interference for a short period of time, but this should not, or is very unlikely to affect measurements reported by the radar sensor continuously.

4.5. Fogging and Evaporation

Generally, radar sensors are not affected by fog or evaporation of water unless very heavy evaporation is present and water density in the air is very high. Very high amount of evaporation can introduce reflections and can affect measurements of the surface velocity sensor. In the case of evaporation, the best solution for surface velocity sensor problem solving is to use outbound flow direction and to configure the sensor with only downstream directional filter. As evaporation is traveling upwards from the water surface, inbound or approaching to the radar, the directional filter will solve the problem in the majority of cases.

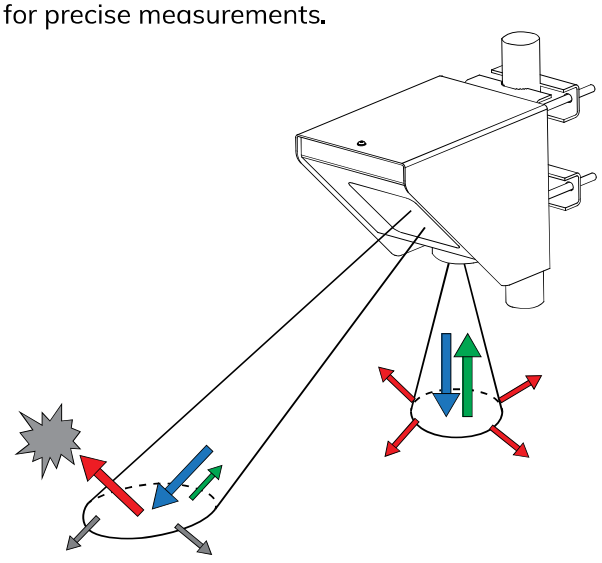
The best solution for distance measurement is, in most cases, to increase the average period of the averaging filter. As evaporation is naturally a turbulent event with significant difference in density over the surface area and in time, averaging of the distance measurement spectrum solves the accuracy problem in such conditions.

4.6. Reflections

Water reflects radar signals very well, which means most of the power of a wave transmitted from the radar transmitter will be reflected from the surface of the water.

Reflections of the radar beam transmitted power follow the same physical laws as in optics and every time the radar beam hits the water surface, part of the power is reflected away from the radar, part of the power is reflected towards the radar and only a small part of the power is absorbed by the water. Depending on the surface roughness and incident angle, the ratio between the power reflected in the direction away from the radar and the direction back towards the radar can significantly vary.

The ratio between the reflections is determined by water surface roughness. Generally, the rougher the water surface, the stronger the reflections towards the radar will be, thus easier detection and greater SNR (Signal to Noise Ratio) can be achieved which enables greater measurement accuracy. Geolux surface velocity radar is designed with special techniques to achieve accurate measurements even in environments with very small SNR, so the required surface roughness of 1 mm is usually enough for precise measurements.



Picture 6. Reflections of the Radar Beam

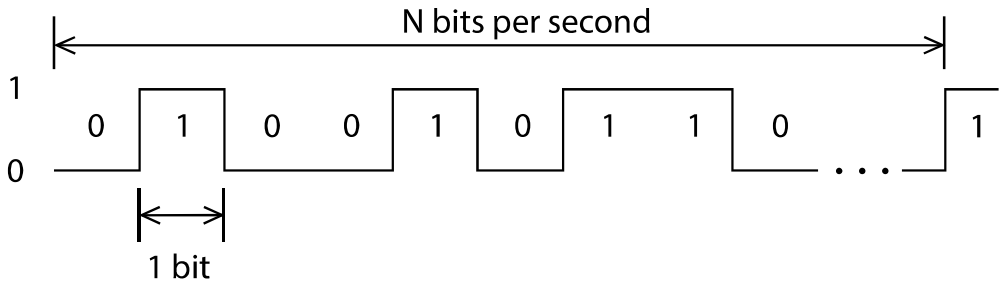
When selecting a location for installing the RSS-2-300WL instrument, additional care must be taken to avoid that any part of the radar beam that is reflected away from the instrument (red arrow) hits any nearby moving objects (grey cloud). Such additional radar reflections can significantly affect measurement accuracy. Installations where pedestrians, cars or other objects are moving in front of the sensor closer than 75 meters should be avoided as it is proven in practice that it can cause problems.

Indoor applications are generally not recommended as it could lead to wrong readings due to the reflection of the radar beam hitting any moving or rotating object which could cause false readings.

5 Flow Meter Settings

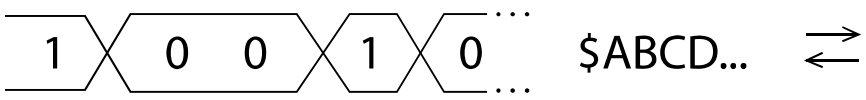
Communication Interfaces Parameters

Baud rate



Baud rate - Configures the baud rate (bits per second) for serial communication on both RS-232 and RS-485 data lines. This setting controls how many bits are sent on the communication line in one second. The available values are standardized. Using higher baud rates over longer lines may introduce errors in transferred data. The default instrument baud rate is 9600 bps.

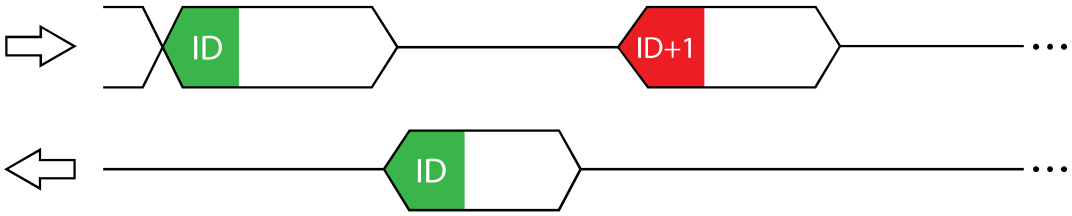
RS-232 and RS-485 protocol



RS-232 protocol - Selects the communication protocol to be used for data communication on RS-232 interface. The NMEA protocol is a GPS-like human readable messaging protocol where each data packet contains a checksum for data integrity verification.

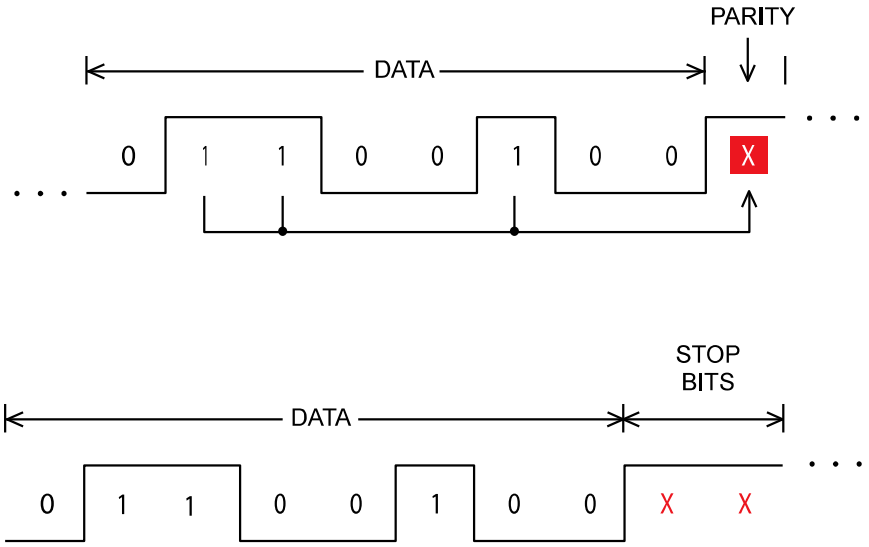
RS-485 protocol - Selects the communication protocol to be used on RS-485 half-duplex interface. HS protocol is a simple request-response protocol for the simplest applications. Modbus RTU protocol is a standardized protocol which is commonly used in automation and instrumentation as it provides all measurements with detailed diagnostics of device operation and the possibility to change the instrument's operating parameters.

Device ID



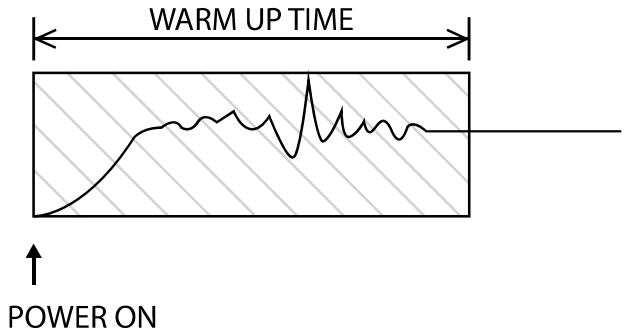
Device ID - Configures the device (slave) ID to be used on RS-485 interface protocols (Modbus RTU or HS). Both protocols use request/response format and allow multiple instruments to be connected on the same bus. When a remote master transmits the request message, it will use the device ID as a device address. All instruments will receive the request, but only the instrument with the matching device ID will answer to the received request.

Modbus settings



Modbus settings - Configures the parity and number of stop bits used in communication. Parity is used in serial communication for basic error detection. When parity is set to *None*, no parity is used, and no error detection is possible on bit level. When parity is set to *Odd parity*, an additional bit is added to the communication that will be set to 1 when there is an odd number of bits with value 1 in the 8-bit payload byte. Similarly, when parity is set to *Even parity*, an additional bit is added to the communication that will be set to 1 when there is an even number of bits with value 1 in the 8-bit payload byte. Generally, all bytes on the receiver side where the parity bit is not matching the message will be discarded. The default setting on most devices that use Modbus is even parity. Stop bits are added to the end of each data byte transferred over serial communication, to allow pause between two bytes. One or two bits may be used. The default setting is even parity and one stop bit.

Warm up time

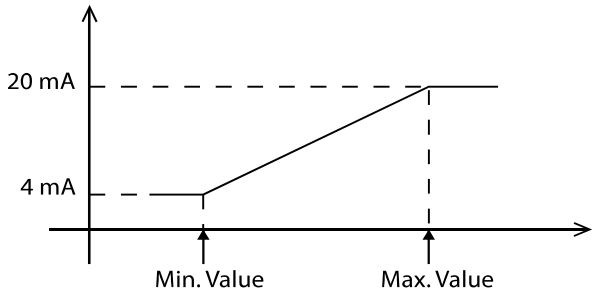


Warm up time - The time after sensor power-up, during which all measurements are ignored. This time is used to settle auto-gain parameters, Kalman filter values, averaging filter, and all other operational parameters. It is recommended to set this value to a minimum of 5 seconds. In extreme cases where a quick response after unit power-up is required, 3 seconds can be used, with a possibility of losing measurement accuracy.

4 – 20 mA output

4 – 20 mA output - This parameter is used to select the value that will correspond to the 4 – 20 mA output. When *Velocity* is selected, the output current will be proportional to the measured velocity. When *Level* is selected, the output current will be proportional to the measured level and when *Discharge* is selected, the output current will be proportional to the calculated discharge. When *None* is selected, the 4 – 20 mA output will be disabled.

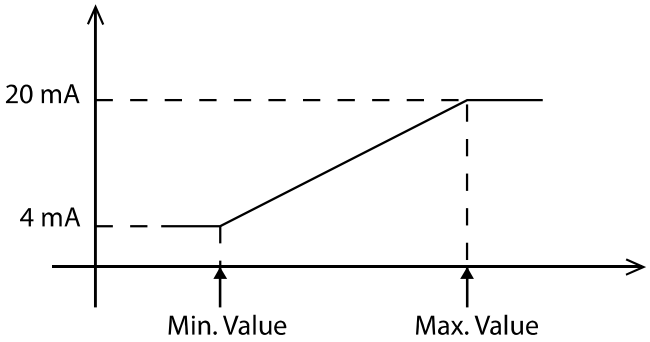
4 – 20 mA min. and 4 – 20 mA max.



4 – 20 mA min. – To configure the 4 – 20 mA output range, the minimum measured value which will correspond to 4 mA analog output needs to be set. The value is set in the currently configured measurement unit. Example: if values measured by the instrument are expected to be within the range of 700 mm/s up to 1500 mm/s, it is recommended to configure the minimum value to slightly below 700 mm/s (for example 500 mm/s). Alternatively, if the resolution is not critical, then the minimum value for 4 – 20 mA output can be left to the instrument minimum of 0 mm/s.

4 – 20 mA max. – To configure the 4 – 20 mA output range, the maximum measured value which will correspond to 20 mA analog output needs to be set. The value is set in the currently configured measurement unit. Example: if values measured by the instrument are expected to be within the range of 700 mm/s up to 1500 mm/s, it is recommended to configure the maximum value to slightly above 1500 mm/s (for example 2000 mm/s). Alternatively, if the resolution is not critical, then the maximum value for 4 – 20 mA output can be left to the instrument maximum of 15000 mm/s.

Level 4 – 20 mA min. and 4 – 20 mA max.



Level 4 – 20 mA min. –To configure the 4 – 20 mA output range, the minimum measured value which will correspond to 4 mA analog output needs to be set. The value is set in the currently configured measurement unit. Example: if values measured by the instrument are expected to be within the range of 700 mm up to 5000 mm, it is recommended to configure the minimum value to slightly below 700 mm (for example 500 mm). Alternatively, if the resolution is not critical, then the minimum value for 4 – 20 mA output can be left to the instrument minimum of 0 mm.

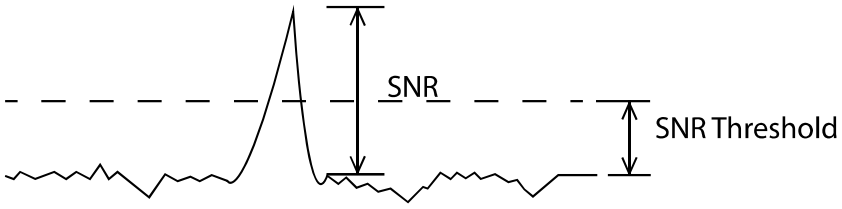
Level 4 – 20 mA max. – To configure the 4 – 20 mA output range, the maximum measured value which will correspond to 20 mA analog output needs to be set. The value is set in the currently configured measurement unit. Example: if values measured by the instrument are expected to be within the range of 700 mm up to 5000 mm, it is recommended to configure the maximum value to slightly above 5000 mm/s (for example 6000 mm). Alternatively, if the resolution is not critical, then the maximum value for 4 – 20 mA output can be left to the instrument maximum.

Processing Parameters

Sensitivity level

Sensitivity level – Configures the radar sensitivity level. The sensitivity level threshold is used by the radar to determine whether the reflected signal is too low to detect any flow. If the instrument is incorrectly reporting flow when there is no water in the channel, it's necessary to increase the value of this parameter.

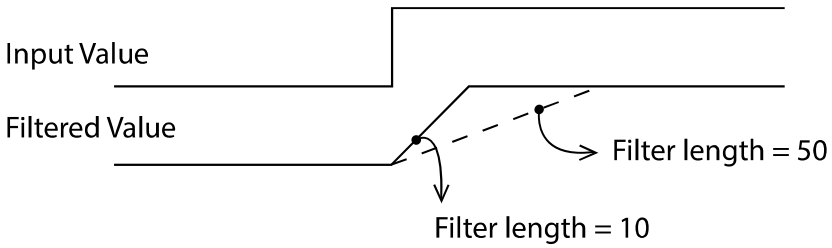
SNR threshold



SNR threshold – The minimal Signal to Noise Ratio that is required to detect water flow. If the actual measured SNR is lower than the threshold, the instrument will not report any flow. Setting SNR threshold to a higher value will result with more robust measurements but may also result with no measurements when the water is very smooth. Generally, measurements with SNR below 10 dB may be inaccurate, and measurements with SNR below 6 dB should not be trusted. The SNR threshold should be set accordingly. The SNR is calculated according to the following formula, where A_peak is the absolute signal level amplitude at the detected peak, and A_avg is the average signal level amplitude of the complete signal, except for the detected peak:

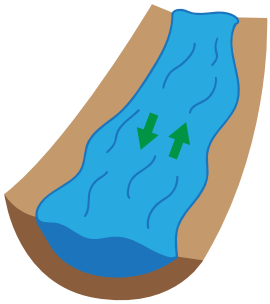
$$SNR = 10 * \log(A\_peak / A\_avg)$$

Filter length



Filter length – The length of the averaging filter, in number of readings, to smoothen the measured values. The instrument performs 10 readings per second, so a filter length value of 50 will result in 5 second integration time. When using longer filter lengths, more measured values are used for filtering, and the resulting data will be smoother. However, when the surface velocity changes, it will take more time for the new measurement to be reported. Typically, this parameter should be set to a value between 50 and 200. For highly turbulent water, longer filter length is recommended.

Direction filter



Direction filter – Direction filter is used to choose whether the instrument will detect flow in both directions, or if it should detect only incoming or only outgoing flow. If the direction filter is set to both directions, the instrument will measure the flow velocity in any direction and will also report the actual direction of the flow. If the direction filter is set to incoming direction, then the instrument will reject all radar returns that correspond to outgoing flow, and vice versa. On monitoring sites where it is expected that the flow will always be in only one direction, it is recommended to properly configure this parameter to either incoming or outgoing, as that will improve the consistency of measurements.

Extra fast

Extra fast – Enables or disables the extra fast setting. When the radar is powered-up in normal operation mode, it will need a few seconds to self-configure in an optimal way for the current flow conditions. This is not necessary with stable flow conditions when the strength of the reflected radar signal is high (which can be checked by monitoring the reported SNR value). In that case, enabling the extra fast setting will force the radar to skip self-configuration and save a few seconds at power-up before the first measurement is reported.

Peak width

Peak width – When a velocity peak is detected, this parameter tells the radar how wide to consider the side velocities for the final velocity report. If the flow is uniform across the surface, then normal peak width can be selected.

Level filter type

Changing the type of filter which is used to smoothen the measured data.

No filter **-** No filtering is used and the raw measurements are reported.

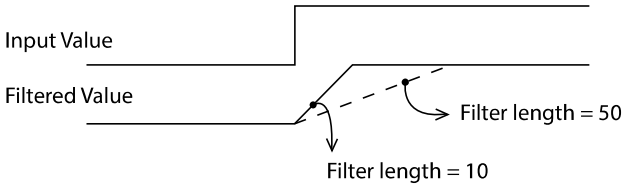
IIR - Infinite-Impulse Response filter is used to smooth the data. When compared to moving average filter, IIR filter reacts more quickly to initial change in the data, but it takes longer for the smoothed value to reach the new measurement. The use of IIR filter is discouraged for general applications. The IIR constant can be configured separately.

Moving average - The moving average filter calculates the average value of a number of raw measurements. The length for the moving average filter is configured separately through the *Filter Length* parameter.

Median **-** The median filter finds the median value from a number of raw measurements. The length for the median filter is configured separately through the *Filter Length* parameter

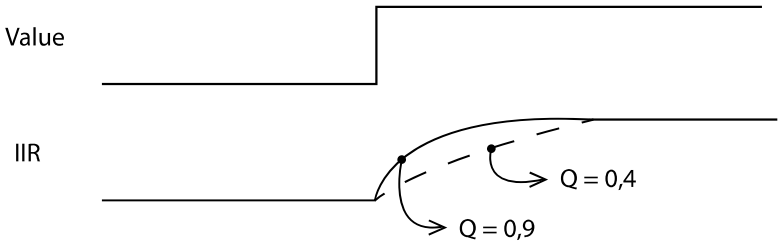
Standard deviation **-** This type of filter is similar to the moving average filter. It takes a number of raw measurements (as defined by the *Filter Length* parameter), then removes 20% of outliers, and calculates the average of the remaining 80% of values.

Level filter length



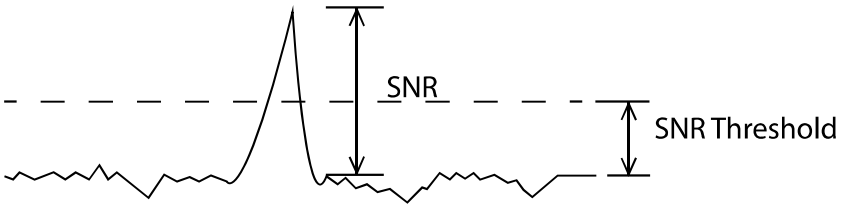
Level filter length – The length of the averaging filter, in number of readings, to smooth the measured values. The instrument performs 1 reading per second, so a filter length value of 10 will result in 10 seconds integration time. When using longer filter lengths, more measured values are used for filtering, and the resulting data will be smoother. However, when the water level changes, it will take more time for the new measurement to be reported. Typically, this parameter should be set to a value between 10 and 50. For highly turbulent water, longer filter length is recommended.

IIR constant



IIR constant - The constant used by Infinite-Impulse Response (IIR) filter if IIR filter type is selected. Accepted values are decimal numbers between 0 and 1. When the IIR constant value is closer to 0.0, the filter response will be slower. When the IIR constant value is closer to 1.0, then the filter response will be faster.

Amplitude threshold



Amplitude threshold - Setting the minimum amplitude of the spectral peak in signal analysis algorithm required to detect peaks and report distance. If no peak above this value is detected, the sensor will report distance equal to 0. The threshold is used to filter noise and false readings and it is recommended to keep this value between 0 and 1000.

Peak detector type

Peak detector type - Configuring the type of algorithm which is used to detect the peaks in the radar echo curve. The default setting should be *Maximum peak*. In specific cases, such as when a water level needs to be measured, but there is a lot of vegetation protruding from the water surface, *Last peak* detector type should be used.

Measurement Parameters

Discharge unit

Discharge unit – The measurement unit used to report the measured discharge value.

Velocity unit

Velocity unit – The measurement unit used to report the measured velocity value. For NMEA protocol which is used over RS-232 connection, the velocity is reported as an integer value. To preserve higher precision with integer numbers, the measured velocity will be multiplied by 10 for m/s, km/h, mph, fps and fpm when being transferred over RS-232. When mm/s and cm/s units are used, the measured values will not be multiplied by 10. The Geolux Instrument Configurator PC application internally handles the multiplication factor which is used over RS-232 protocol, and it displays the correct values to the user.

Level unit

Level unit – The measurement unit used to report the measured level value. The default measurement unit is millimetres. When changing the measurement unit, it's important to make sure that other parameters which depend on the measurement unit (such as active zone parameters) are also changed to the new unit.

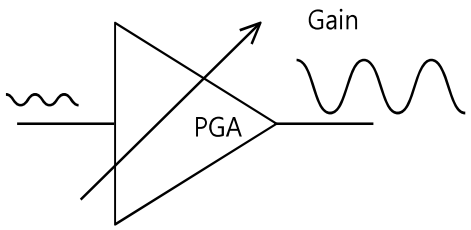
Totalizer unit

Totalizer unit – The measurement unit used to report the total flow volume.

Area unit

Area unit – The measurement unit used to report the cross-section area of the submerged channel profile.

PGA sensitivity

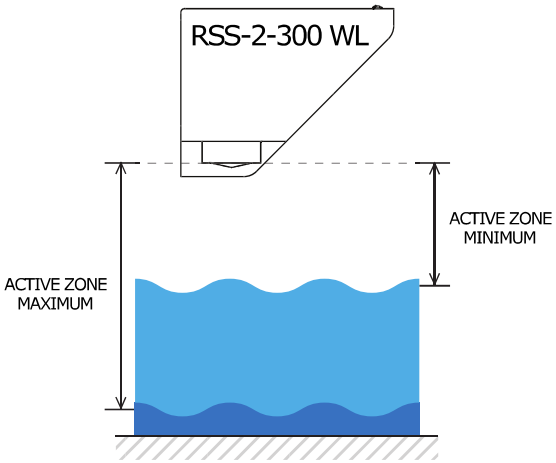


PGA sensitivity – This parameter limits the maximum gain (amplification level) of the internal programmable gain amplifier. It is strongly recommended to use the default value 8, which allows the internal signal amplifier to use the maximum gain when the reflected radar signal is very low. Setting this value to a lower value is used only when the instrument is mounted very close to the water surface, typically less than 1 metre, and in that case this parameter should be set to a value of 4 or 5.

Velocity min. and Velocity max.

Velocity min. - This parameter is used for setting up the minimum velocity value of interest.
Velocity max. - This parameter is used for setting up the maximum velocity value of interest.

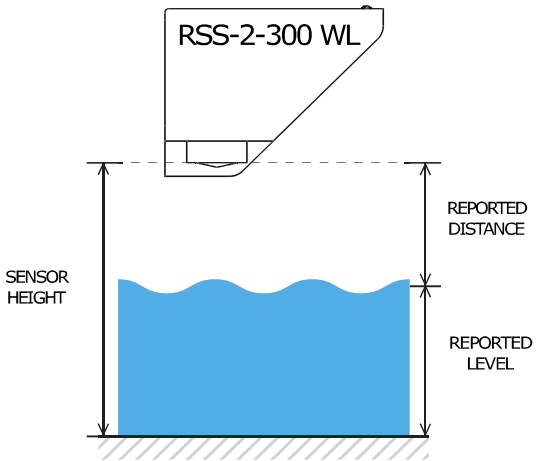
Level active zone parameters



This parameter limits the operational range of the instrument. The instrument will detect water level only within the range set by the *Active zone min.* and *Active zone max.* parameters. This parameter is the best way to filter unwanted radar reflections from other structures and objects that are present on the monitoring site, which could cause false instrument readings.

Active zone min. - It is strongly recommended to set the *Active zone min.* value to the minimum possible distance between the water and the instrument at the specific monitoring site.
Active zone max. - It is strongly recommended to set the *Active zone max.* value to the maximum possible distance between the water and the instrument at the specific monitoring site. Typically, this is the distance between the instrument and the lowest point in the channel.

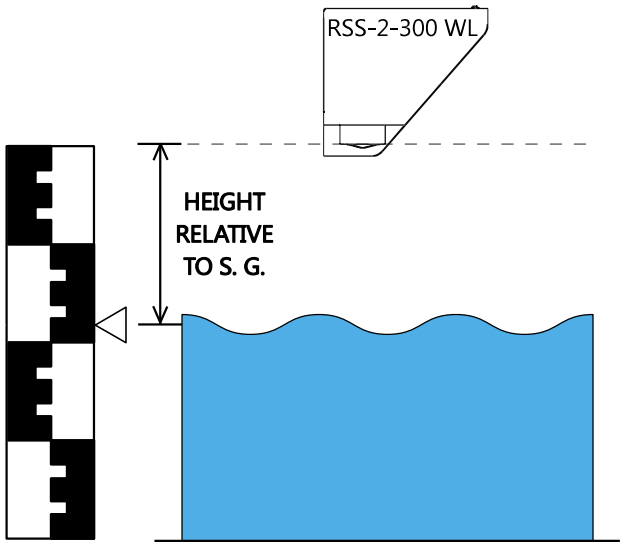
Level sensor height



Level sensor height - The height of the instrument needs to be set above the water zero-level "gauge zero". The instrument will output relative measurement of the actual water level based on its height above the water zero-level. Example: if the instrument is mounted exactly 5 metres above the gauge

zero level, then this parameter should be set to 5 metres. Then, if the instrument measures that the distance between the instrument and the water is 4 metres, it will report that the water level is 1 metre, because the water is 1 metre above the gauge-zero level. For user convenience, this parameter can also be indirectly set by inputting the current staff gauge reading.

Staff gauge



Staff gauge - Setting the sensor height relative to the measurement is done using staff gauge. The sensor will output relative measurement of the actual water level based on its height above the riverbed.

Power management

Power management - Switching the device between continuous scanning mode and SDI-12 sleep modes. In continuous mode the device constantly makes the measurements, which are transmitted over RS-232 interface and made available over Modbus and SDI-12 interfaces. The device is always available over RS-232 and Modbus interfaces. In any SDI-12 sleep mode, the device remains in the sleep mode until SDI-12 Measure (aM!) command is received. While in deep sleep mode, the device will not be able to connect to Modbus or RS-232 interface. For reconfiguring the device which is set to operate in SDI-12 deep sleep mode, it's necessary to power-cycle the device, and then use this application to connect to the device within 20 seconds after power-up. If there is no attempt to connect to the device over RS-232 within 20 seconds, the device will automatically go back to sleep mode. The device consumes only 0.08W while in standby mode, and 0.04 W while in sleep mode.

Totalizer calculation

Enables or disables the calculation of the total flow volume.

Totalizer hard save

Enables or disables the totalizer hard save. When the setting is enabled, the current total flow volume value will be saved to flash in case of device reset, and upon power-up, new values will be added to the saved value. If the setting is disabled the total flow volume calculation will be reset and start from 0.

Dynamic flow profiler

Enables or disables the dynamic flow profiler funcionality. The default value is 0 (Disabled).

Main output value

Configures whether the average velocity value or the dynamic flow profiler velocity value will be used as the main output for velocity measurement. The default value is 0 (Average velocity value).

6 Data Interface

Geolux RSS-2-300WL flow meter offers multiple data interfaces, in order to make the integration of the device with existing SCADA/telemetry systems easy.

6.1. Serial RS-232 Interface

Serial RS-232 interface is used for direct connection of a single surface velocity radar unit with the computer. The serial interface is used both for retrieving live flow measurements and for configuration of the surface velocity radar device. Geolux provides a PC application for unit configuration and flow monitoring free of charge.

Default communication parameters are:

Bitrate:	9600 bps
Data bits:	8
Stop bits:	1
Parity:	None

A NMEA-like communication protocol is used to deliver flow measurements over RS-232 interface. Detailed description of the protocol is given in chapter 7 of this user manual.

6.2. Serial RS-485 Interface

Serial RS-485 interface is used for connecting multiple flow meters to a single data logger. RS-485 interface uses a different protocol then the protocol used over RS-232 interface, in order to allow multiple surface velocity radars connected on a single RS-485 bus. The main difference from the protocol used over RS-232 interface is that the flow measurements are not reported automatically, but are instead reported only after being requested by the master device (data logger unit). Detailed description of the protocol is given in chapter 7 of this user manual.

Default communication parameters are:

Bitrate:	9600 bps
Data bits:	8
Stop bits:	1
Parity:	Even
Device ID:	1

7 Data Protocols

Geolux RSS-2-300WL flow meter supports the following data protocols:

- NMEA-like protocol on RS-232 interface that constantly outputs the detected speed, distance (level), discharge and reflected signal power, and also the current measured tilt angles of both the surface velocity sensor and the level meter
- Servicing protocol on RS-232 interface for configuring the unit
- Request-response protocol on RS-485 interface that allows multiple units to be used on a single RS-485 bus
- Modbus-RTU protocol on RS-485 interface which is supported by variety of third-party data loggers

Support for additional protocols is available upon customer request.

7.1. NMEA Protocol (RS-232)

NMEA protocol is based on the standard protocol family widely used by navigation equipment. NMEA protocol is sentence oriented and is capable of sending multiple sentences with different information. The sentence content is designated by the starting keyword which is different for each sentence type. NMEA sentences are terminated with the checksum which makes this protocol extremely reliable. NMEA protocol is a single-direction protocol: data is only transmitted from the flow meter. At RS-232 interface the device periodically outputs following data sentences:

Direct flow measurement report

$RDTGT,D1,S1,L1*CSUM<CR><LF>

$RDTGT:	The keyword sent in the beginning of each detection report. This sentence is sent whenever there is detected flow.
D1:	The detected flow direction (1 approaching, -1 receding).
S1:	The detected flow speed (speed is reported as speed*10 for m/s, km/h, mph, fps, fpm and as speed*1 for mm/s and cm/s).
L1:	The detected level of the signal reflection from the water surface.
CSUM:	The check sum of the characters in the report from $ to * excluding these characters.

Average flow measurement report

$RDAVG,S1*CSUM<CR><LF>

$RDAVG:	The keyword sent in the beginning of the report. This sentence reports smoothed flow measurement. This is the preferred reading, since it filters out minor fluctuations in flow speed reading due to waves.
S1:	The detected flow speed (speed is reported as speed*10 for m/s, km/h, mph, fps, fpm and as speed*1 for mm/s and cm/s).
CSUM:	The check sum of the characters in the report from $ to * excluding these characters.

Tilt angle report

$RDANG,A*CSUM<CR><LF>

$RDANG:	The keyword sent in the beginning of each tilt angle report.
A:	The measured tilt angle, in degrees, 0 being horizontal.
CSUM:	The check sum of the characters in the report from $ to * excluding these characters.

Signal SNR report

$RDSNR,S1,S2*CSUM<CR><LF>

$RDSNR:	The keyword sent in the beginning of each SNR report.
S1:	The current SNR of measured velocity signal in dBm.
S2:	The average SNR of measured velocity signal in dBm.
CSUM:	The check sum of the characters in the report from $ to * excluding these characters.

Quality of signal report

$QOS,Q1,Q2*CSUM<CR><LF>

$QOS:	The keyword sent in the beginning of each quality of signal report.
Q1:	This is an indicator of the Quality of the Service (measurements) related to the instrument vibrations. If the instrument is vibrating, the measurements may be incorrect, and the amount of vibrations is measured and reported. Geolux Instrument Configurator color-codes
Q2:	This is an indicator of the Quality of the Service (measurements) related to the radar signals. Geolux Instrument Configurator color-codes these values. Measurements can be trusted when QoS is green. Measurements may be inaccurate when the indicator is yellow or red.
CSUM:	The check sum of the characters in the report from $ to * excluding these characters.

Quality of signal factors and corresponding color codes:

0 – Excellent measurement quality (Green)
1 – Good measurement quality (Green)
2 – Low measurement quality (Yellow)
3 – Unacceptable measurement quality (Red)

Discharge report

$DIS,D*CSUM<CR><LF>

$DIS:	The keyword sent in the beginning of each discharge report.
D:	The measured discharge, in defined units.
CSUM:	The check sum of the characters in the report from $ to * excluding these characters.

Cross-section area report

$AREA,A*CSUM<CR><LF>

$AREA:	The keyword sent in the beginning of each area report.
A:	The calculated cross-section area of the submerged channel profile, in selected units.
CSUM:	The check sum of the characters in the report from $ to * excluding these characters.

Total volume report

$TOT,T1,T2*CSUM<CR><LF>

$TOT:	The keyword sent in the beginning of each totalizer report.
T1:	The total flow volume value, in defined units.
T2:	Time, in seconds, during which the calculation has been active (drops to 0 on device reset).
CSUM:	The check sum of the characters in the report from $ to * excluding these characters.

The total volume report is only visible if the *Totalizer calculation* parameter is set to 1.

Water level report

$LVL,L1,L2,T1,L3,L4,S1,S2*CSUM<CR><LF>

$LVL:	The keyword sent in the beginning of each level report.
L1:	Current distance from sensor to water, in defined units, 0 being sensor reference plane. If reporting -4 then there is no detected level.
L2:	Average distance from sensor to water, in defined units, 0 being sensor reference plane. If reporting -4 then there is no detected level.
T1:	Internal device temperature (in °C).
L3:	Current relative detected level, in defined units, 0 being sensor reference plane.
L4:	Average relative detected level, in defined units, 0 being sensor reference plane.

S1:	Measurement SNR (in dBm). A value of -99 indicates a serious problem with the device - contact Geolux support.
S2:	The standard deviation of water level measurements. The number of samples used to calculate the standard deviation is equal to the configured filter length.
CSUM:	The check sum of the characters in the report from $ to * excluding these characters.

Level sensor tilt angle report

$LVLANG,A1,A2 *CSUM<CR><LF>

$LVLANG:	The keyword sent in the beginning of each level sensor tilt angle report.
A1:	The tilt angle of the instrument along X axis. For proper operation of the instrument, ensure that this angle is zero, or as close to zero as possible (between -1 and +1 degrees).
A2:	The tilt angle of the instrument along Y axis. For proper operation of the instrument ensure that this angle is zero, or as close to zero as possible (between -1 and +1 degrees).
CSUM:	The check sum of the characters in the report from $ to * excluding these characters.

7.2. Servicing Protocol (RS-232)

The servicing protocol is used to retrieve and modify device operating parameters. Various device settings, such as unit system and filtering parameters are configured using this protocol. Since NMEA protocol is one way (it only outputs the data), the servicing protocol is always active.

To make radar configuration easy, Geolux provides the Geolux Instrument Configurator utility application. Regular users do not need to be concerned about the servicing protocol used between the Geolux Instrument Configurator and the surface velocity radar device. Geolux Instrument Configurator is described in chapter 8 of this manual.

The servicing protocol listens on RS-232 serial port for incoming requests, and on each received request, it will answer back.
The following requests are recognized by the servicing protocol and every command should be followed by <CR>, <LF> or <CR><LF> (enter):

Change interfaces parameters:

Baud rate - Configures the baud rate (bits per second) for serial communication on both RS-232 and RS-485 data lines. This setting controls how many bits are sent on the communication line in one second. The available values are standardized. Using higher baud rates over longer lines may introduce errors in transferred data. The default instrument baud rate is 9600 bps.

#set_baud_rate=9600
#set_baud_rate=19200
#set_baud_rate=38400
#set_baud_rate=57600
#set_baud_rate=115200

RS-232 protocol - Selects the communication protocol to be used for data communication on RS-232 interface. The NMEA protocol is a GPS-like human readable messaging protocol where each data packet contains a checksum for data integrity verification.

#set_proto=nmea

RS-485 protocol - Selects the communication protocol to be used on RS-485 half-duplex interface. HS protocol is a simple request-response protocol for the simplest applications. Modbus RTU protocol is a standardized protocol which is commonly used in automation and instrumentation as it provides all measurements with detailed diagnostics of device operation and the possibility to change the instrument's operating parameters. GLZIMA protocol is a measurement push protocol that sends data on a defined time interval. Between measurement cycles, the device enters sleep mode and wakes up on its own after the defined time interval has elapsed.

#set_485_proto=modbus_rtu
#set_485_proto=hs
#set_485_proto=glzima

GLZIMA sleep period - The interval between two GLZIMA protocol measurement cycles. Between measurement cycles, the device enters sleep mode and wakes up on its own after this time interval has elapsed.

#set_glzima_sleep_sec=<0,1800>

Device ID - Configures the device (slave) ID to be used on RS-485 interface protocols (Modbus RTU or HS) and SDI-12 interface. All protocols use request/response format and allow multiple instruments to be connected on the same bus. When a remote master transmits the request message, it will use the device ID as a device address. All instruments will receive the request, but only the instrument with the matching device ID will answer to the received request. Note that the ID used for RS-485 protocols is in the range of 1 to 247 (0 is not allowed), while the SDI-12 ID can be 0-9, A-Z and a-z (numerically corresponding to 0-61), so values greater than 61 are not valid).

#set_can_id=<0-247>

Modbus settings - Configures the parity and number of stop bits used in communication. Parity is used in serial communication for basic error detection. When parity is set to *None*, no parity is used, and no error detection is possible on bit level. When parity is set to *Odd parity*, an additional bit is added to the communication that will be set to 1 when there is an odd number of bits with value 1 in the 8-bit payload byte. Similarly, when parity is set to *Even parity*, an additional bit is added to the communication that will be set to 1 when there is an even number of bits with value 1 in the 8-bit payload byte. Generally, all bytes on the receiver side where the parity bit is not matching the message will be discarded. The default setting on most devices that use Modbus is even parity. Stop bits are added to the end of each data byte transferred over serial communication, to allow pause between two bytes. One or two stop bits can be used. The default setting is even parity and one stop bit.

#set_485_modbus_type=0 (no parity, one stop bit)
#set_485_modbus_type=1 (no parity, two stop bits)
#set_485_modbus_type=2 (event parity, one stop bit (default)
#set_485_modbus_type=3 (odd parity, one stop bit)

Warm up time - The time after sensor power-up, during which all measurements are ignored. This time is used to settle auto-gain parameters, Kalman filter values, averaging filter, and all other operational parameters. It is recommended to set this value to a minimum of 5 seconds. In extreme cases where a quick response after unit power-up is required, 3 seconds can be used, with a possibility of losing measurement accuracy.

#set_dead_time=<3-100>

4 – 20 mA output - This parameter is used to select the value that will correspond to the 4 – 20 mA output. When *Velocity* is selected the output current will be proportional to the measured velocity. When *Level* is selected the output current will be proportional to the measured level and when *Discharge* is selected the output current will be proportional to the calculated discharge. When *None* is selected the 4 – 20 mA output will be disabled.

#set_an420_type=velocity
#set_an420_type=level
#set_an420_type=discharge
#set_an420_type=none

4 – 20 mA min. – To configure the 4 – 20 mA output range, the minimum measured value which will correspond to 4 mA analog output needs to be set. The value is set in the currently configured measurement unit. Example: if values measured by the instrument are expected to be within the range of 700 mm/s up to 1500 mm/s, it is recommended to configure the minimum value to slightly below 700 mm/s (for example 500 mm/s). Alternatively, if the resolution is not critical, then the minimum value for 4 – 20 mA output can be left to the instrument minimum of 0 mm/s.

#set_an420_min=<value>

4 – 20 mA max. – To configure the 4 – 20 mA output range, the maximum measured value which will correspond to 20 mA analog output needs to be set. The value is set in the currently configured measurement unit. Example: if values measured by the instrument are expected to be within the range of 700 mm/s up to 1500 mm/s, it is recommended to configure the maximum value to slightly above 1500 mm/s (for example 2000 mm/s). Alternatively, if the resolution is not critical, then the maximum value for 4 – 20 mA output can be left to the instrument maximum of 15000 mm/s.

#set_an420_max=<value>

Level 4 – 20 mA min. – To configure the 4 – 20 mA output range, the minimum measured value which will correspond to 4 mA analog output needs to be set. The value is set in the currently configured measurement unit. Example: if values measured by the instrument are expected to be within the range of 700 mm up to 5000 mm, it is recommended to configure the minimum value to slightly below 700 mm (for example 500 mm). Alternatively, if the resolution is not critical, then the minimum value for 4 – 20 mA output can be left to the instrument minimum of 0 mm.

#set_lvl_420_max=<value>

Level 4 – 20 mA max. – To configure the 4 – 20 mA output range, the maximum measured value which will correspond to 20 mA analog output needs to be set. The value is set in the currently configured measurement unit. Example: if values measured by the instrument are expected to be within the range of 700 mm up to 5000 mm, it is recommended to configure the maximum value to slightly above 5000 mm/s (for example 6000 mm). Alternatively, if the resolution is not critical, then the maximum value for 4 – 20 mA output can be left to the instrument maximum.

#set_ lvl_420_max=<value>

Change processing parameters:

Sensitivity level - Configures the radar sensitivity level. The sensitivity level threshold is used by the radar to determine whether the reflected signal is too low to detect any flow. If the instrument is incorrectly reporting flow when there is no water in the channel, it's necessary to increase the value of this parameter.

#set_thld=<0-100>

SNR threshold - The minimal Signal to Noise Ratio that is required to detect water flow. If the actual measured SNR is lower than the threshold, the instrument will not report any flow. Setting SNR threshold to a higher value will result with more robust measurements but may also result with no measurements when the water is very smooth. Generally, the measurements with SNR below 10 dB may be inaccurate, and measurements with SNR below 6 dB should not be trusted. The SNR threshold should be set accordingly. The SNR is calculated according to the following formula, where A_peak is the absolute signal level amplitude at the detected peak, and A_avg is the average signal level amplitude of the complete signal, except for the detected peak:

$$SNR = 10 * \log(A\_peak / A\_avg)$$

#set_thld_snr=<0-5120>

Filter length - The length of the averaging filter, in number of readings, to smoothen the measured values. The instrument performs 10 readings per second, so a filter length value of 50 will result in 5 second integration time. When using longer filter lengths, more measured values are used for filtering, and the resulting data will be smoother. However, when the surface velocity changes, it will take more time for the new measurement to be reported. Typically, this parameter should be set to a value between 50 and 200. For highly turbulent water, longer filter length is recommended.

#set_filter_len=<1-1000>

Direction filter - Direction filter is used to choose whether the instrument will detect flow in both directions, or if it should detect only incoming or only outgoing flow. If the direction filter is set to both directions, the instrument will measure the flow velocity in any direction and will also report the actual direction of the flow. If the direction filter is set to incoming direction, then the instrument will reject all radar returns that correspond to outgoing flow, and vice versa. On monitoring sites where it is expected that the flow will always be in only one direction, it is recommended to properly configure this parameter to either incoming or outgoing, as that will improve the consistency of measurements.

#set_direction=in
#set_direction=out
#set_direction=both

Extra fast - Enables or disables the extra fast setting. When the radar is powered-up in normal operation mode, it will need a few seconds to self-configure in an optimal way for the current flow conditions. This is not necessary with stable flow conditions when the strength of the reflected radar signal is high (which can be checked by monitoring the reported SNR value). In that case, enabling the extra fast setting will force the radar to skip self-configuration and save a few seconds at power-up before the first measurement is reported.

#set_extra_fast=0 (Disabled)
#set_extra_fast=1 (Enabled)

Peak width - When a velocity peak is detected, this parameter tells the radar how wide to consider the side velocities for the final velocity report. If the flow is uniform across the surface, then normal peak width can be selected.

#set_peak_width=0 (Very narrow)
#set_peak_width=1 (Narrow)
#set_peak_width=2 (Normal)
#set_peak_width=3 (Wide)

Level filter type - Changing the type of filter used for smoothing measured data.

No filter - No filtering is used and the raw measurements are reported.

IIR - Infinite-Impulse Response filter is used to smooth the data. When compared to moving average filter, IIR filter reacts more quickly to initial change in the data, but it takes longer for the smoothed value to reach the new measurement. The use of IIR filter is discouraged for general applications. The IIR constant can be configured separately.

Moving average - The moving average filter calculates the average value of a number of raw measurements. The length for the moving average filter is configured separately through *Filter length* parameter.

Median - The median filter finds the median value from a number of raw measurements. The length for the median filter is configured separately through *Filter length* parameter.

Standard deviation - This type of filter is similar to the moving average filter. It takes a number of raw measurements (as defined by *Filter length* parameter), then removes 20% of outliers, and calculates the average of the remaining 80% of values.

#set_lvl_filter_type=0 (No filter)
#set_lvl_filter_type=1 (IRR)
#set_lvl_filter_type=2 (Moving average)
#set_lvl_filter_type=3 (Median)
#set_lvl_filter_type=4 (Standard deviation)

Level filter length - The length of the averaging filter, in number of readings, to smooth the measured values. The instrument performs 1 reading per second, so a filter length value of 10 will result in 10 seconds integration time. When using longer filter lengths, more measured values are used for filtering, and the resulting data will be smoother. However, when the water level changes, it will take more time for the new measurement to be reported. Typically, this parameter should be set to a value between 10 and 50. For highly turbulent water, longer filter length is recommended.

#set_lvl_filter_len=<1-1000>

IIR constant - The constant used by Infinite-Impulse Response (IIR) filter if IIR filter type is selected. Accepted values are decimal numbers between 0 and 1. When the IIR constant value is closer to 0.0, the filter response will be slower. When the IIR constant value is closer to 1.0, then the filter response will be faster.

#set_IR_constant=<0-1>

Amplitude threshold - Setting the minimum amplitude of the spectral peak in the signal analysis algorithm required to detect peaks and report distance. If no peak above this value is detected, the sensor will report distance equal to 0. The threshold is used to filter noise and false readings and it is recommended to keep this value between 0 and 1000.

#set_lvl_amplitude_threshold=<0,65535>

Peak detector type - Configuring the type of algorithm which is used to detect the peaks in the radar echo curve. The default setting should be *Maximum peak*. In specific cases, such as when the water level needs to be measured, but there is a lot of vegetation protruding from the water surface, *Last peak* detector type should be used.

#set_lvl_peak_detector=0 (Maximum peak)
#set_lvl_peak_detector=1 (Last peak)
#set_lvl_peak_detector=2 (First peak)

Change processing parameters:

Discharge unit - The measurement unit used to report the measured discharge value.

#set_discharge_units=m3s
#set_discharge_units=liters
#set_discharge_units=ft3s

Velocity unit - The measurement unit used to report the measured velocity value. For NMEA protocol which is used over RS-232 connection, the velocity is reported as an integer value. To preserve higher precision with integer numbers, the measured velocity will be multiplied by 10 for m/s, km/h, mph, fps and fpm when being transferred over RS-232. When mm/s and cm/s units are used, the measured values will not be multiplied by 10. The Geolux Instrument Configurator PC application internally handles the multiplication factor which is used over RS-232 protocol, and it displays the correct values to the user.

#set_units=kmh
#set_units=mph
#set_units=fps
#set_units=fpm
#set_units=ms
#set_units=mms
#set_units=cms

Level unit - The measurement unit used to report the measured level value. The default measurement unit is millimetres. When changing the measurement unit, it's important to make sure that other parameters which depend on the measurement unit (such as active zone parameters) are also changed to the new unit.

#set_lvl_units=mm
#set_lvl_units=cm
#set_lvl_units=m
#set_lvl_units=in
#set_lvl_units=ft

Totalizer unit - The measurement unit used to report the total flow volume.

#set_totalizer_units=0 (m^3)
#set_totalizer_units=1 (L)
#set_totalizer_units=2 (ft^3)

Area unit - The measurement unit used to report the cross-section area of the submerged channel profile.

#set_area_units=0 (mm^2)
#set_area_units=1 (cm^2)
#set_area_units=2 (m^2)
#set_area_units=4 (in^2)
#set_area_units=5 (ft^2)

PGA sensitivity - This parameter limits the maximum gain (amplification level) of the internal programmable gain amplifier. It is strongly recommended to use the default value 8, which allows the internal signal amplifier to use the maximum gain when the reflected radar signal is very low. Setting this value to a lower value is used only when the instrument is mounted very close to the water surface, typically less than 1 metre, and in that case this parameter should be set to a value of 4 or 5.

#set_sensitivity=<0-8>

Velocity min. - This parameter is used for setting up the minimum velocity value of interest.

#set_min_velocity=<value>

Velocity max. - This parameter is used for setting up the maximum velocity value of interest.

#set_max_velocity=<value>

Level active zone min. - This parameter limits the operational range of the instrument. The instrument will detect water level only within the range set by the *Active zone min.* and *Active zone max.* parameters. This parameter is the best way to filter unwanted radar reflections from other structures and objects that are present on the monitoring site, that could cause false instrument readings. It is strongly recommended to set the *Active zone min.* value to the minimum possible distance between the water and the instrument at the specific monitoring site.

#set_lvl_deadzone_min=<value>

Level active zone max. - This parameter limits the operational range of the instrument. The instrument will detect water level only within the range set by the *Active zone min.* and *Active zone max.* parameters. This parameter is the best way to filter unwanted radar reflections from other structures and objects that are present on the monitoring site, that could cause false instrument readings. It is strongly recommended to set the *Active zone max.* value to the maximum possible distance between the water and the instrument at the specific monitoring site. Typically, this is the distance between the instrument and the lowest point in the channel.

#set_lvl_deadzone_max=<value>

Level sensor height - The height of the instrument needs to be set above the water zero-level "gauge zero". The instrument will output relative measurements of the actual water level based on its height above the water zero-level. Example: if the instrument is mounted exactly 5 metres above the gauge zero level, then this parameter should be set to 5 metres. Then, if the instrument measures that the distance between the instrument and the water is 4 metres, it will report that the water level is 1 metre, because the water is 1 metre above the gauge-zero level. For user convenience, this parameter can also be indirectly set by inputting the current staff gauge reading.

#set_lvl_sensor_height=<value>

Level sensor staff gauge - Setting the sensor height relative to the measurement is done using staff gauge. The sensor will output relative measurement of the actual water level based on its height above the riverbed.

#set_lvl_staff_gauge=<value>

Power management - Switching between continuous scanning mode, standby mode and sleep mode. Standby and sleep modes are set when the SDI-12 interface is planned to be used. In continuous scanning mode, the device continuously performs measurements which are transmitted over the RS-232 interface and made available over Modbus and SDI-12 interfaces. In standby and sleep modes, the device remains in sleep mode until SDI-12 Measure (aM!) command is received. While in sleep mode, the device will not be able to connect to Modbus or RS-232 interfaces. In order to reconfigure a device which is set to operate in SDI-12 sleep mode, it's necessary to power-cycle the device and then use the Geolux Instrument Configurator PC application to connect to the device within 20 seconds after power-up. If there is no attempt to connect to the device over RS-232 interface within 20 seconds, the device will automatically go back to sleep mode. The device consumes only 0.08 W while in standby mode, and 0.04 W while in sleep mode.

#set_sdi12_sleep=0 (Continuous scanning)
#set_sdi12_sleep=1 (Standby mode)
#set_sdi12_sleep=2 (Sleep mode)

Device in sleep mode - This command puts device in sleep mode, in order to reconfigure a device which is in sleep mode, it's necessary to send any command.

#radar_sleep

Reset device settings to default factory settings - This command resets all settings on the device (Interface, Processing, Measurement and Profile Settings) to default factory settings.

#radar_reset_default

Totalizer calculation - This command enables or disables the totalizer calculation.

#set_totalizer_calc=0 (Disabled)
#set_totalizer_calc=1 (Enabled)

Totalizer hard save - This command enables or disables the totalizer hard save. When the setting is enabled, the current total flow volume value will be saved to flash in case of device reset, and upon power-up, new values will be added to the saved value. If the setting is disabled the total flow volume calculation will be reset and start from 0.

#set_totalizer_hardsave=0 (Disabled)
#set_totalizer_hardsave=1 (Enabled)

Totalizer reset - This command resets the totalizer measurement.

#totalizer_reset

Dynamic flow profiler - This command enables or disables the dynamic flow profiler funcionality. The default value is 0 (Disabled).

#set_dfp_en=0 (Disabled)
#set_dfp_en=1 (Enabled)

Main output value - When the DFP functionality is enabled, this command configures whether the average velocity value or the dynamic flow profiler velocity value will be used as the main output for velocity measurement. The default value is 0 (Average velocity value).

#set_dfp_use_as_main=0 (Average velocity value)
#set_dfp_use_as_main=1 (Dynamic flow profiler velocity value)

Change DFP parameters:

When the DFP funcionality is enabled, the following commands can be used to configure the DFP parameters:

Minimum DFP level - The minimum level (in millimetres) at which the DFP velocity value is calculated. The default value is 0.

#set_dfp_lvl_min_mm=<value>

Maximum DFP level - The maximum level (in millimetres) at which the DFP velocity value is calculated. The default value is 30000.

#set_dfp_lvl_max_mm=<value>

Ratio filter - The ratio filter utilizes a percentage (by default, set at 20%) to incorporate the dynamic flow profiler into the current measrement. With this filter, a stable DFP value for a specific level allows the output velocity value to consist of 20% DFP velocity and 80% current measured velocity. This filter serves the purpose of smoothing out abrupt transitions from periods with no measurements to periods with available measurements. Each level has the flexibility to configure its own ratio accordingly.

#set_dfp_ratio_fil_en=0 (Disabled)
#set_dfp_ratio_fil_en=1 (Enabled)

Ratio - The ratio used for the ratio filter. The default value is 80.

#set_dfp_ratio=<0-100>

DFP level SNR threshold - When the level SNR value surpasses this threshold, the velocity measurement will be stored for the dynamic flow profiler funcionality. The default value is 20.

#set_dfp_lvl_snr_thr=<value>

DFP velocity SNR threshold - When the velocity SNR value surpasses this threshold, the velocity measurement will be stored for the dynamic flow profiler funcionality. The default value is 11.

#set_dfp_vel_snr_thr=<value>

Below minimum threshold velocity - This setting enables or disables the usage of DFP velocity as the main velocity below the defined Minimum DFP level. The velocity is obatined by interpolation between zero and the first DFP level point velocity.

#set_dfp_low_vel_as_main=0 (Disabled)
#set_dfp_low_vel_as_main=1 (Enabled)

Obtaining the DFP Settings:

To get the status of all of the DFP settings the following command can be used:

#dfp_get_info

The response to this command can be either just:

dfp_en:0

if the DFP funcionality is disabled, or:

dfp_en:1
dfp_lvl_min_mm:<value_mm>
dfp_lvl_max_mm:<value_mm>
dfp_use_as_main:<0,1>
dfp_vel_snr_thr:<value>
dfp_lvl_snr_thr:<value>
dfp_ratio_fil_en:<0,1>
dfp_ratio:<value>
dfp_low_vel_as_main:<0,1>

if the DFP funcionality is enabled.

Obtaining the DFP Measurements Status:

The DFP measurements status for a specific level can be obtained via RS-232 or RS-485 interface. To get the measurements status for a specific level over the RS-232 interface, the following command should be issued:

#dfp_get_status_lvl_mm=<value_mm>

where *<value_mm>* is the distance from the sensor to the desired level. The sensor will give the following response:

#dfp_status_lvl:<def_value_mm>,<threshold_min_write>,
<threshold_max_write>,<threshold_min>,<threshold_max>,
<measurement_cnt>,<history_id_used_curent>,<history_id_cnt>,
<age_of_current_history_block>

#dfp_msr_incoming_status_lvl:<msr_cnt>,<min_val>,
<max_val>,<mean>,<std_dev>

#dfp_msr_outgoing_status_lvl:<msr_cnt>,<min_val>,
<max_val>,<mean>,<std_dev>

where the following notation applies:

<def_value_mm> - The defined value used for the DFP functionality

<threshold_min_write> - Minimum value, corresponding to the defined value, that will be used for the DFP funcionality. Values below this threshold will not be stored for the DFP functionality.

<threshold_max_write> - Maximum value, corresponding to the defined value, that will be used for the DFP funcionality. Values above this threshold will not be stored for the DFP functionality.

<threshold_min> - Minimum value corresponding to the defined value.

<*threshold_max*> - Maximum value corresponding to the defined value.

<*measurement_cnt*> - Measurement count.

<*history_id_used_curent*> - ID of the current block.

<*history_id_cnt*> - Number of predefined blocks used for the defined value.

<*age_of_current_history_block*> - Relative age of DFP points.

<*msr_cnt*> - Number of velocity measurements.

<*min_val*> - Minimum velocity measurement value.

<*max_val*> - Maximum velocity measurement value.

<*mean*> - Mean velocity measurement value.

<*std_dev*> - Standard deviation of velocity measurements.

It is also possible to get the measurements status for all configured levels at once by issuing the following command:

#dfp_get_status_all

The format for each configured level status response is the same as the status response for a single level. The response to the above command can vary from 1 to 10 seconds, depending on the number of DFP points configured.

Obtaining the Saved DFP Measurements:

Obtaining measurements is only available via the RS-232 interface by sending the following command:

#dfp_print_msrs=<value_mm>,<request_count_msrs>

where <*value_mm*> is the value for which the measurements are requested, while <*request_count_msrs*> is the number of measurements to fetch. If a large number of measurements is requested, the sensor will send the measurements in chunks of the following format:

#dfp_print_msrs:<dfp_point_value_mm>,<request_count_msrs>,
<msrs_offset>,<current_msrs_cnt>;
<msr_1>,<msr_2>,<msr_3>, ... ,<msr_current_data_cnt>,

where the following notation applies:

<*dfp_point_level_mm*> - The DFP point value in millimetres closest to requested <*value_mm*>

<*request_count_msrs*> - The requested number of measurements

<*msrs_offset*> - The offset of data sent in the current chunk. This offset is the number of measurements, not the number of chunks.

<*current_msrs_cnt*> - The count of measurements that will be sent in the current chunk.

<*msr_1*>,<*msr_2*>,<*msr_3*>, ... ,<*msr_current_data_cnt*> - The measurements that are sent separated with a colon. Positive values represent the incoming velocity values and negative values represent the outgoing velocity values.

All measurements have been sent when the sensor responds with:

#dfp_print_msrs:OK

Storing (Importing) Measurements for a Specific Level:

Storing measurement for a specific level is done via the RS-232 interface by sending two (or more) separate commands. First, the level point (distance from the sensor to the desired water level) must be set, and then the measurements can be imported:

command: #set_dfp_custom_lvl_point=<value_mm>
response: #set_dfp_custom_lvl_point:OK

command: #dfp_save_msr=<vel_1>,<vel_2>,...,<vel_20>
response: #dfp_save_msr:OK

Using these two commands, the user can store custom velocity measurements to the sensor. *<value_mm>* represents the distance (in millimetres) from the sensor to the desired level for which the measurements will be stored, while *<vel_1>,<vel_2>*, etc. represent the measurements, which can be positive or negative. Positive values represent the incoming velocity values, while the negative values represent the outgoing velocity values. The maximum number of velocity values per command is 20, so if there are more than 20 velocity values that need to be stored, multiple *#dfp_save_msr* commands must be sent.

Resetting the DFP Measurements for a Specific Level:

If, for some reason, the user wants to reset the measurements saved for a specific level, the following command can be used:

#dfp_reset_lvl_mm=<level_mm>,<flag_leave_last_block_of_measurements>

where *<value_mm>* represents the distance (in millimetres) from the sensor to the desired level. The *<flag_leave_last_block_of_measurements>* can be set to either 0 or 1. If it is set to 0 all of the measurements will be erased. If it is set to 1, the last block of measurements will remain, while all the previous measurements will be erased.

Resetting All of the DFP Measurements:

If the discharge parameters (k-factors and corresponding levels), the level sensor height, or the DFP range (minimum or maximum DFP value) have been changed, the saved DFP measurements will no longer be valid and need to be reset. The following command is used to reset all of the saved DFP measurements:

#dfp_reset

Retrieve current device status

#get_info

Requests the current device status. Here is an example status output:

```
# firmware:6.5.7

# serial:123456
# sensor_type:WL
# direction:both
# baud_rate:9600
# dead_time:10
# can_id:1
# angle:160
# filter_type:2
# filter_len:50
# fft_integ_time:0
# pga_gain:20
# proto:nmea
# 485_proto:modbus_rtu
# 485_modbus_type:2
# units:mms
# sensitivity:8 (Auto)
# thld:124
# thld_snr:1024
# an420_type:9
# an420_min:0.000
# an420_max:10000.000
# min_velocity:0.000
# max_velocity:15000.000
# border_velocity:500.000
# extra_fast:0
# power_save:0
# level_sensor:2
# sdi12_sleep:0
# totalizer_hardsave:0
# totalizer_calc:1
# discharge_units:liters
# totalizer_units:m3
# area_units :m2
# lvl_units:mm
# lvl_firmware:240
# lvl_filter_type:4
# lvl_filter_len:20
# lvl_deadzone_min:200.000
# lvl_deadzone_max:15000.000
# lvl_420_min:0.000
# lvl_420_max:15000.000
# lvl_sensor_height:5470.000
# lvl_peak_detector:0
# lvl_aplitude_threshold:0
```

7.3. HS Protocol

A different data protocol is used on RS-485 interface which allows connection of multiple units on the single RS-485 line. Before the units are connected on the single RS-485 bus, each unit must be configured with a different device identifier. The device identifier is configured by using the PC application. Please check Chapter 7 for instructions.

The HS protocol is a request-response protocol which, unlike NMEA protocol, does not automatically report periodic flow measurement readings. Instead, when the unit is polled form the data logger, it

responds the measurement.

The request is sent from the data logger to the flow meter:

<0x25> ID CSUM

0x25: The first byte sent in the request is '%' character. Its ASCII value in HEX is 0x25.

ID: Exactly two bytes long. This is the unit ID written as two ASCII characters. For example, if the polled unit ID is 2, then ID will be sent as "02". In HEX representation it is the following two bytes: <0x30><0x32>.

CSUM: Checksum, calculated by adding in modulo 256 the two byte values of the ID. If the device ID is 2, then ID was sent as <0x30><0x32>. Checksum is then 0x30+0x32 = <0x62>.

After receiving the request, if the device ID matches, the flow meter will respond with the current averaged flow velocity reading:

<0xA5> ID SPEED;LEVEL CSUM

0xA5: The first byte sent in the response is byte with HEX value of 0xA5.

ID: Exactly two bytes long. This is the unit ID written as two ASCII characters. For example, if the unit ID is 2, then ID will be sent as "02". In HEX representation it is the following two bytes: <0x30><0x32>.

SPEED: The speed readout in currently selected units, formatted as real (float) number with exactly three digits after the decimal dot separator. For example, if the current averaged speed is 5.7143, it will be reported as 5.714, or in HEX values: <0x35><0x2E><0x37><0x31><0x34><0x33>.

LEVEL: The level readout in meters, formatted as a real (float) number with exactly three digits after the decimal dot separator. For example, if the current averaged level is 5.7143, it will be reported as 5.714, or in HEX values: <0x35><0x2E><0x37><0x31><0x34><0x33>.

CSUM: Checksum, calculated by adding in modulo 256 the two byte values of the ID and all byte values from the SPEED.

The command that puts the instrument to *Power save mode* is as follows:

<0x2b> ID CSUM:

0x2b: The first byte sent in the request is '+' character. Its ASCII value in HEX is 0x2b.

ID: Exactly two bytes long. This is the unit ID written as two ASCII characters. For example, if the polled unit ID is 2, then ID will be sent as "02". In HEX representation it is the following two bytes: <0x30><0x32>.

CSUM: Checksum, calculated by adding in modulo 256 the two byte values of the ID. If the device ID is 2, then ID was sent as <0x30><0x32>. Checksum is then 0x30+0x32 = <0x62>.

After receiving the request, the device goes to power save mode.

The command that restores the instrument from *Power save mode* to normal *Operational mode* is as follows:

<0x2d> ID CSUM

0x2d: The first byte sent in the request is '-' character. Its ASCII value in HEX is 0x2d.

ID: Exactly two bytes long. This is the unit ID written as two ASCII characters. For example, if the polled unit ID is 2, then ID will be sent as "02". In HEX representation it is the following two bytes: <0x30><0x32>.

CSUM: Checksum, calculated by adding in modulo 256 the two byte values of the ID. If the device ID is 2, then ID was sent as <0x30><0x32>. Checksum is then 0x30+0x32 = <0x62>

After receiving the request, the device goes from *Power save mode* to normal *Operational mode*.

7.4. Modbus Protocol (RS-485)

When configured in Modbus operation mode, the unit responds to Modbus requests over RS-485 data line. The baud rate and device ID configured through the PC application, and 1 stop bit, even parity, 8 data bits configuration is used.

Modbus registers that are accessed by Modbus protocol are 16-bit (2-byte) registers. Any number of registers can be read or written to over Modbus.

Modbus is a request-response protocol where a master (such as datalogger) sends out requests, and slave devices (such as RSS-2-300WL sensor) respond. The request and response format, with examples is given in tables 3-6.

In each request, the master can either ask the slave to retrieve the value of one or more registers, or the master can set the value of one or more registers. Each register holds one 16-bit value.

Table 3. Master Request Format

Name	Address	Fun	Data Start Address		Register Count		CRC16	
Length	1 byte	1 byte	2 bytes (H,L)		2 bytes (H,L)		2 bytes (L,H)	
Example	0x01	0x03	0x00	0x00	0x00	0x01	0x84	0x0A

Table 4. Request Example

Name	Content	Detail
Address	0x01	Slave address (Sensor id)
Function	0x03	Read slave info
Data Start Address	0x00	The address of the first register to read (HIGH)
	0x00	The address of the first register to read (LOW) – Sensor ID registers
Number of Regs	0x00	High
	0x01	Low (read only 1 register)
CRC16	0x84	CRC Low
	0x0A	CRC High

Table 5. Slave (Sensor) Response Format

Name	Address	Fun	Byte Count	Data		CRC16	
Length	1 byte	1 byte	1 byte	2 bytes(H,L)		2 bytes(L,H)	
Example	0x01	0x03	0x02	0x00	0x01	0x79	0x84

Table 6. Response Example

Name	Content	Detail
Address	0x01	Slave address (Sensor id)
Function	0x03	Read slave info
Data Length	0x02	Data length is 2 bytes
Data	0x00	Data high byte
	0x01	Data low byte, means ID is 1
CRC16	0x79	CRC Low
	0x84	CRC High

Table 7 defines the data returned by the unit when the master requests that the register is read. Table 8 defines how to write device configuration. Rows highlighted in blue denote the important values measured by the sensor. Rows highlighted in green denote operating parameters that can be changed in the field. In Tables 7 and 8, field *Fun* corresponds to Modbus function codes, i.e. 0x03 – *Read holding register* and 0x06 – *Write holding register*.

Table 7. Retrieving Data from the Sensor

Fun	Register Address	Data Length	Data Range	Details
0x03	0x0000	2 bytes	1 – 247	Read device ID
	0x0001	2 bytes	0 → 9600 1 → 38400 2 → 57600 3 → 115200 4 → 19200	Read baud rate
	0x0002	2 bytes	0 → mm/s 1 → m/s 2 → mph 3 → km/h 4 → fps 5 → fpm 6 → cm/s	Read velocity unit type
	0x0003	2 bytes	0 – 15000 (mm/s)	Read instantaneous speed
	0x0004	2 bytes	0 – 15000 (mm/s)	Read averaged speed
	0x0005	2 bytes	0 – 360	Read tilt angle
	0x0006	2 bytes	0 → incoming 1 → outgoing	Read flow direction
	0x0007	2 bytes	1 – 512	Read filter length
	0x0008	2 bytes	0 – 8	Read defined PGA gain sensitivity
	0x0009	2 bytes	0 → both 1 → incoming 2 → outgoing	Read flow direction filter setting
	0x000A	2 bytes	0 – 100	Read sensitivity value
	0x000B	2 bytes	1	Read device type, always 1
	0x000C	2 bytes	0 – 3840	Read SNR threshold (dBm * 256)
	0x000D	2 bytes	621	Read firmware code 6.2.1
	0x000E	2 bytes	1,2,5,10,20,50,100,200	Read current PGA gain level
	0x000F	2 bytes	0 – 2047	Read relative signal level
	0x0010	2 bytes	0 – 65535	Read instantaneous speed in selected units (integer part)
	0x0011	2 bytes	0 – 65535	Read instantaneous speed in selected units (decimal part * 1000)
	0x0012	2 bytes	0 – 65535	Read averaged speed in selected units (integer part)
	0x0013	2 bytes	0 – 65535	Read averaged speed in selected units (decimal part * 1000)
	0x0014	2 bytes	0 – 10000	Read instantaneous SNR level (dBM * 256)

Fun	Register Address	Data Length	Data Range	Details
0x03	0x0015	2 bytes	0 – 10000	Read averaged SNR level (dBM * 256)
	0x0016	2 bytes	3 printable characters	Read serial number [0-2]
	0x0017	2 bytes	3 printable characters	Read serial number [3-5]
	0x0018	2 bytes	0 → excellent 1 → good 2 → low 3 → unacceptable	Read QoS - angle, vibrations - first 2 bits of first byte Read QoS - signal - second 2 bits of first byte. (example 0x0B is QOS angle 3 and QOS signal 2)
	0x0019 – 0x001A	2 bytes	0	Reserved, always 0
	0x001B	2 bytes	0 → very narrow 1 → narrow 2 → normal 3 → wide	Read peak width
	0x001C	2 bytes	0 – 15000	Read velocity min. (mm/s)
	0x001D	2 bytes	0 – 15000	Read velocity max. (mm/s)
	0x001E	2 bytes	0 → turned off 1 → turned on	Extra fast setting
	0x001F	2 bytes	0	Reserved, always 0
	0x0020	2 bytes	0 – 65535	Read calculated water discharge, integer part in selected units
	0x0021	2 bytes	0 – 65535	Read calculated water discharge, decimal part in selected units
	0x0022	2 bytes	0 – 65535	Read distance to water surface, integer part in selected units
	0x0023	2 bytes	0 – 65535	Read distance to water surface, decimal part in selected units
	0x0024	2 bytes	0 – 65535	Read measured water level, integer part in selected units, relative to defined staff gauge zero
	0x0025	2 bytes	0 – 65535	Read measured water level, decimal part in selected units, relative to defined staff gauge zero
	0x0026	2 bytes	0 – 10000	Read level sensor SNR level (dBM * 256)
	0x0027	2 bytes	0 – 150	Read temperature from level sensor (Celsius)

Fun	Register Address	Data Length	Data Range	Details
0x03	0x0028	2 bytes	0 – 200	Read number of frames for level sensor window filtering
	0x0029	2 bytes	0 → no filter 1 → IIR filter 2 → moving average 3 → median filter 4 → standard deviation	Read filter type for level sensor
	0x002A	2 bytes	0 – 1000	Read level sensor IR filter constant
	0x002B	2 bytes	0 – level range	Read level sensor active zone minimum in selected units
	0x002C	2 bytes	0 – level range	Read level sensor active zone maximum in selected units
	0x002D	2 bytes	0 → mm 1 → cm 2 → m 3 → in 4 → ft	Read level sensor unit type
	0x002E	2 bytes	0 → m^3/s 1 → L/s 2 → ft^3/s	Read discharge unit type
	0x002F	2 bytes	0 → maximum peak 1 → last peak 2 → first peak	Read peak detector type for level sensor
	0x0030	2 bytes	0 – 65335	Read level spectrum amplitude threshold
	0x0031	2 bytes	Standard deviation	Read standard deviation of measurement
	0x0032	2 bytes	0 – 360	Read level sensor x-axis tilt angle
	0x0033	2 bytes	0 – 360	Read level sensor y-axis tilt angle
	0x0034	2 bytes	239	Read level sensor firmware code
	0x0035	2 bytes	0 – 65335	Read sensor height
	0x0037	2 bytes	0 – 65335	Read cross-section area in selected unit (integer part)
	0x0038	2 bytes	0 – 65335	Read cross-section area in selected unit (decimal part * 1000)
	0x0039	2 bytes	0 – 65335	Read total flow volume in selected units - first 16 bits. (For value 0x123456789ABCDEF0 this register is showing 0xDEF0)

Fun	Register Address	Data Length	Data Range	Details
0x03	0x003A	2 bytes	0 – 65335	Read total flow volume in selected units - second 16 bits
	0x003B	2 bytes	0 – 65335	Read total flow volume in selected units - third 16 bits
	0x003C	2 bytes	0 – 65335	Read total flow volume in selected units - fourth 16 bits
	0x003D	2 bytes	0 – 65335	Read totalizer active time - first 16 bits. (For value 0x12345678, this register is showing 0x5678)
	0x003E	2 bytes	0 – 65335	Read totalizer active time - second 16 bits
	0x003F	2 bytes	0	Reserved, always 0
	0x0040	2 bytes	0 → m^3 1 → L/s 2 → ft^3	Read totalizer unit type
	0x0041	2 bytes	0 → mm^2 1 → cm^2 2 → m^2 3 → in^2 4 → ft^2	Read area unit type
	0x0042	2 bytes	0 → disabled 1 → enabled	Read totalizer calculation
	0x0043	2 bytes	0 → disabled 1 → enabled	Read totalizer hard save setting
	0x0044 – 0x0049	2 bytes	0	Reserved, always 0
	0x004A	2 bytes	0 → disabled 1 → enabled	Dynamic flow profiler functionality
	0x004B – 0x0050	2 bytes	0	Reserved, always 0
	0x0051	2 bytes	0 → turned off 1 → turned on	Read low power mode
	0x0052 – 0x07FF	2 bytes	0	Reserved, always 0
	0x0800	2 bytes	0 – 30000	Minimum DFP level
	0x0801	2 bytes	0 – 30000	Maximum DFP level
	0x0802	2 bytes	0 – 65335	DFP level SNR threshold
	0x0803	2 bytes	0 – 65335	DFP velocity SNR threshold
	0x0804	2 bytes	0 → average velocity value 1 → DFP velocity value	Use DFP velocity value as main value

Fun	Register Address	Data Length	Data Range	Details
0x03	0X0805	2 bytes	0 → disabled 1 → enabled	Ratio filter
	0X0806	2 bytes	0 – 100	Ratio
	0X0807	2 bytes	0 → disabled 1 → enabled	Use below minimum threshold velocity

Table 8. Writing Data to the Sensor

Fun	Register Address	Data Length	Data Range	Details
0x06	0X0000	2 bytes	1 – 247	Change device ID
	0X0001	2 bytes	0 → 9600 1 → 38400 2 → 57600 3 → 115200 4 → 19200	Change baud rate
	0X0002	2 bytes	0 → mm/s 1 → m/s 2 → mph 3 → km/h 4 → fps 5 → fpm 6 → cm/s	Change velocity unit type
	0X0007	2 bytes	1 – 512	Change filter length
	0X0008	2 bytes	0 – 8	Change PGA gain sensitivity
	0X0009	2 bytes	0 → both 1 → incoming 2 → outgoing	Change flow direction filter type
	0X000A	2 bytes	0 – 100	Change sensitivity level
	0X000C	2 bytes	0 – 3840	Change SNR threshold (dBm * 256)
	0x001B	2 bytes	0 → very narrow 1 → narrow 2 → normal 3 → wide	Change peak width
	0x001C	2 bytes	0-15000	Change velocity min. (mm/s)
	0x001D	2 bytes	0-15000	Change velocity max. (mm/s)
	0x001F	2 bytes	0 → turned off 1 → turned on	Change extra fast setting
	0x0028	2 bytes	0 – 200	Change number of frames for level sensor window filtering

Fun	Register Address	Data Length	Data Range	Details
	0x0029	2 bytes	0 → no filter 1 → IIR filter 2 → moving average 3 → median filter 4 → standard deviation	Change level sensor filter type
	0x002A	2 bytes	0 – 1000	Change level sensor IR filter constant $IR_{const} = \frac{value_{int}}{1000}$
	0x002B	2 bytes	0 – level range	Change level sensor active zone minimum in defined units
	0x002C	2 bytes	0 – level range	Change level sensor active zone minimum in defined units
	0x002D	2 byte	0 → mm 1 → cm 2 → m 3 → in 4 → ft	Change level sensor unit type
	0x002E	2 bytes	0 → m^3/s 1 → L/s 2 → ft^3/s	Change discharge unit type
	0x002F	2 bytes	0 → maximum peak 1 → last peak 2 → first peak	Change peak detector type for level sensor
	0x0030	2 bytes	0 – 65335	Change level spectrum amplitude threshold
	0x0035	2 bytes	0 – 65335	Change sensor height
	0x0036	2 bytes	0 – 65335	Enter staff gauge
	0x0040	2 bytes	0 → m^3 1 → L/s 2 → ft^3	Change totalizer unit type
	0x0041	2 bytes	0 → mm^2 1 → cm^2 2 → m^2 3 → in^2 4 → ft^2	Change area unit type
	0x0042	2 bytes	0 → disabled 1 → enabled	Enable/disable totalizer calculation
	0x0043	2 bytes	0 → disabled 1 → enabled	Enable/disable totalizer hard save setting
	0x0044	2 bytes	1	Totalizer reset
	0x004A	2 bytes	0 → disabled 1 → enabled	Dynamic flow profiler functionality
	0x0051	2 bytes	0 → turned off 1 → turned on	Change low power mode

Fun	Register Address	Data Length	Data Range	Details
0x06	0x0800	2 bytes	0 – 30000	Minimum DFP level
	0x0801	2 bytes	0 – 30000	Maximum DFP level
	0x0802	2 bytes	0 – 65335	DFP level SNR threshold
	0x0803	2 bytes	0 – 65335	DFP velocity SNR threshold
	0x0804	2 bytes	0 → average velocity value 1 → DFP velocity value	Use DFP velocity as main value
	0x0805	2 byte	0 → disabled 1 → enabled	Ratio filter
	0x0806	2 bytes	0 – 100	Ratio
	0x0807	2 bytes	0 → disabled 1 → enabled	Use below minimum threshold velocity
	0x0850	2 bytes	1234	Reset DFP setup
	0x0851	2 bytes	Level value in mm	Reset DFP measurements for a specific level

Table 9. shows the registers used to obtain the saved DFP measurements over the RS-485 interface (Modbus). The user must issue the request to read the measurements for a specific level by writing the value in millimetres to register 0x860 and then read the registers 0x861 to 0x879:

Table 9. Obtaining the Saved DFP Measurements

Register	Value	Register	Value
0x0861	<def_value_mm>	0x0870	<incoming_msr_cnt>
0x0862	<threshold_min_write>	0x0871	<incoming_min_val>
0x0863	<threshold_max_write>	0x0872	<incoming_max_val>
0x0864	<threshold_min>	0x0873	<incoming_mean>
0x0865	<threshold_max >	0x0874	<incoming_std_dev>
0x0866	<measurement_cnt>	0x0875	<outgoing_msr_cnt>
0x0867	<history_id_used_curent>	0x0876	<outgoing_min_val>
0x0868	<history_id_cnt>	0x0877	<outgoing_max_val>
0x0869	<age_of_current_history_block>	0x0878	<outgoing_mean>
0x086A - 0x086F	0	0x0879	<outgoing_std_dev>

The descriptions of the values in registers 0x861 to 0x879 in Table 9. are as follows:

<*def_value_mm*> - The defined value used for the DFP functionality

<*threshold_min_write*> - Minimum value, corresponding to the defined value, that will be used for the DFP funcionality. Values below this threshold will not be stored for the DFP functionality.

<*threshold_max_write*> - Maximum value, corresponding to the defined value, that will be used for the DFP funcionality. Values above this threshold will not be stored for the DFP functionality.

<*threshold_min*> - Minimum value corresponding to the defined value.

<*threshold_max*> - Maximum value corresponding to the defined value.

<*measurement_cnt*> - Measurement count.

<*history_id_used_curent*> - ID of the current block.

<*history_id_cnt*> - Number of predefined blocks used for the defined value.

<*age_of_current_history_block*> - Relative age of DFP points.

<*msr_cnt*> - Number of velocity measurements.

<*min_val*> - Minimum velocity measurement value.

<*max_val*> - Maximum velocity measurement value.

<*mean*> - Mean velocity measurement value.

<*std_dev*> - Standard deviation of velocity measurements.

7.4.1. Modbus Input Registers

Modbus input registers are read-only registers. By reading the Modbus input registers the user can view the device type and the firmware version, as well as real-time measurement values in 32-bit integer or 32-bit float format. Since the native Modbus registers are 16-bit registers, to store 32-bit values, two subsequent registers are used. In order to easily check the byte-order and word-order, two pairs of test registers with fixed constant values are provided. One register pair containts a fixed value of 1234567 in 32-bit integer format, and the other register pair contains a fixed value of -123.4567 in 32-bit float format.

Table 10 defines the data returned by the instrument when the master requests that the input register is read (Modbus function code 0x04). Rows highlighted in blue denote the values of interest, while the rows highlighted in green represent reserved registers which can be read but the returned value will always be equal to 0.

Table 10. Retrieving Data from Modbus Input Registers

Fun	Register Address	Data Length	Data Format	Details
0x04	0x0001	2 bytes	16-bit integer	Device type ID
	0x0002	2 bytes	16-bit integer	Firmware version
	0x0003	2 bytes		Reserved - always 0
	0x0004, 0x0005	2 bytes, 2 bytes	32-bit integer	32-bit integer control register pair containing a fixed value of 1234567
	0x0006, 0x0007	2 bytes, 2 bytes	32-bit float	32-bit float control register pair containing a fixed value of -123.4567
	0x0008 - 0x0009	2 bytes		Reserved - always 0
	0x0010, 0x0011	2 bytes, 2 bytes	32-bit float	Water level
	0x0012, 0x0013	2 bytes, 2 bytes	32-bit float	Distance to water
	0x0014, 0x0015	2 bytes, 2 bytes	32-bit float	Average surface velocity
	0x0016, 0x0017	2 bytes, 2 bytes	32-bit float	Current surface velocity
	0x0018, 0x0019	2 bytes, 2 bytes	32-bit float	Discharge
	0x001A, 0x001B	2 bytes, 2 bytes	32-bit float	Area under water
	0x001C, 0x001D	2 bytes, 2 bytes	32-bit float	Level sensor tilt angle, x-axis
	0x001E, 0x001F	2 bytes, 2 bytes	32-bit float	Level sensor tilt angle, y-axis
	0x0020, 0x0021	2 bytes, 2 bytes	32-bit float	Surface velocity sensor tilt angle
	0x0022, 0x0023	2 bytes, 2 bytes	32-bit float	Level SNR
	0x0024, 0x0025	2 bytes, 2 bytes	32-bit float	Surface velocity SNR
	0x0026, 0x0027	2 bytes, 2 bytes	32-bit float	Surface velocity signal strength
	0x0028, 0x0029	2 bytes, 2 bytes	32-bit float	Surface flow direction
	0x002A, 0x002B	2 bytes, 2 bytes	32-bit float	Internal temperature
	0x002C-0x007F	2 bytes		Reserved - always 0

Fun	Register Address	Data Length	Data Format	Details
0x04	0x0080, 0x0081	2 bytes, 2 bytes	32-bit integer	Water level
	0x0082, 0x0083	2 bytes, 2 bytes	32-bit integer	Distance to water
	0x0084, 0x0085	2 bytes, 2 bytes	32-bit integer	Average surface velocity
	0x0086, 0x0087	2 bytes, 2 bytes	32-bit integer	Current surface velocity
	0x0088, 0x0089	2 bytes, 2 bytes	32-bit integer	Discharge
	0x008A, 0x008B	2 bytes, 2 bytes	32-bit integer	Area under water
	0x008C, 0x008D	2 bytes, 2 bytes	32-bit integer	Level sensor tilt angle, x-axis
	0x008E, 0x008F	2 bytes, 2 bytes	32-bit integer	Level sensor tilt angle, y-axis
	0x0090, 0x0091	2 bytes, 2 bytes	32-bit integer	Surface velocity sensor tilt angle
	0x0092, 0x0093	2 bytes, 2 bytes	32-bit integer	Level SNR
	0x0094, 0x0095	2 bytes, 2 bytes	32-bit integer	Surface velocity SNR
	0x0096, 0x0097	2 bytes, 2 bytes	32-bit integer	Surface velocity signal strength
	0x0098, 0x0099	2 bytes, 2 bytes	32-bit integer	Surface flow direction
	0x009A, 0x009B	2 bytes, 2 bytes	32-bit integer	Internal temperature

7.5. SDI-12 Protocol

Supported SDI-12 commands are:
In all commands, 'a' represents the device address. Blue rows indicate that parameters can be set using this command.

Table 11. SDI-12 Commands

Name	Command	Response	Details
Address Query	?!	a<CR><LF>	Device will identify using its SDI-12 address, default address is 1
Ping Sensor	a!	a<CR><LF>	Device will respond if its address is 'a'
Address Change	aAb!	b<CR><LF>	Device will respond if its address is 'a' with its new address 'b'
Send Identification	aI!	a13GEOLUX 2300WLfff<CR><LF>	a – address SDI-12 version – 1.3 vendor identification – GEOLUX sensor model – 2300WL sensor version – fff, where fff is firmware version
Start Verification	aV!	a00001<CR><LF>	One value is ready imminently
Send Data	aD0!	a+d<CR><LF>	d – verification: 0->not ready , 1->ready

Name	Command	Response	Details
Additional Data	aD1! .. aD9!	a0<CR><LF>	No values are returned for additional data.
Start Measurement	aM!/aMC!	ammm9<CR><LF>	9 values are ready within mmm seconds for M command and 12 values are ready within mmm seconds for C command
Send Data	aD0!	a<val0><CR><LF> a<val0><CRC><CR><LF>	val0 → a±f±f+d+d+d <cl><rf> ±f - discharge in defined units ±f - average velocity in defined units +d - average SNR in dBm +d - angle in ° +d - signal quality (3->unacceptable, 2 ->low, 1->good, 0->excellent)
	aD1!	a<val1><CR><LF> a<val1><CRC><CR><LF>	
Additional Data	aD1! .. aD9!	a0<CR><LF> a0<CRC><CR><LF>	val1 → a±f±f±d±f <cl><rf> ±f - relative level depending on sensor height in defined units ±f - distance from sensor to water in defined units ±d - level SNR in dBm ±f - standard deviation of water level in mm
Concurrent Measurement	aC!/aCC!	ammm12<CR><LF>	
Send Data	aD0!	a<val0><CR><LF> a<val0><CRC><CR><LF>	
	aD1!	a<val1><CR><LF> a<val1><CRC><CR><LF>	val2 → a±d+d+d <cl><rf> ±d – internal device temperature in °C +d – measured tilt angle of device in x direction +d – measured tilt angle of device in y direction
	aD2!	a<val2><CR><LF> a<val2><CRC><CR><LF>	
Additional Data	aD3! ... aD9!	a<CR><LF> a<CRC><CR><LF>	No values are returned for additional data.
Continuous Measurement	aR0! ... aR9!	a<CR><LF> a<CRC><CR><LF>	The continuous mode is not supported
Get Velocity Unit	aXGWUN!	a+d<CR><LF>	+d – measurement unit for velocity 0 – mm/s, 1 – m/s, 2 – mph, 3 – km/h, 4 – fps, 5 – fpm
Set Velocity Unit	aXGWUN+d!	a+d<CR><LF>	+d – measurement unit for velocity 0 – mm/s, 1 – m/s, 2 – mph, 3 – km/h, 4 – fps, 5 – fpm
Get Velocity Average Factor	aXGWAV!	a+d<CR><LF>	+d – averaging velocity length 1-512
Set Velocity Average Factor	aXGWAV+d!	a+d<CR><LF>	+d – averaging velocity length 1-512
Get Direction Filter Factor	aXGDFT!	a+d<CR><LF>	+d – direction filter for velocity 0 – both, 1 – incoming, 2 – outgoing

Name	Command	Response	Details
Set Direction Filter Factor	aXGDFT+d!	a+d<CR><LF>	+d – direction filter for velocity 0 – both, 1 – incoming, 2 – outgoing*
Get Velocity Sensitivity Factor	aXGSENS!	a+d<CR><LF>	+d – sensitivity level for velocity 1-100
Set Velocity Sensitivity Factor	aXGSENS+d!	a+d<CR><LF>	+d – sensitivity level for velocity 1-100
Get Measurement Unit for Level	aXGLUN!	a+d<CR><LF>	+d – measurement unit for level 0 – m, 1 – cm, 2 – mm, 3 – in, 4 – ft
Set Measurement Unit for Level	aXGLUN+d!	a+d<CR><LF>	+d – measurement unit for level 0 – m, 1 – cm, 2 – mm, 3 – in, 4 – ft
Get Minimum Active Zone Value	aXGDZ0!	a+f<CR><LF>	+f – active zone minimum value, sensor will not report measurements lower than this
Set Minimum Active Zone Value	aXGDZ0+f!	a+f<CR><LF>	+f – active zone minimum value, sensor will not report measurements lower than this
Get Maximum Active Zone Value	aXGDZ1!	a+f<CR><LF>	+f – active zone maximum value, sensor will not report measurements higher than this
Set Maximum Active Zone Value	aXGDZ1+f!	a+f<CR><LF>	+f – active zone maximum value, sensor will not report measurements higher than this
Get Sensor Height Value	aXGSHR!	a+f<CR><LF>	+f – sensor height above riverbed
Set Sensor Height Value	aXGSHR+f!	a+f<CR><LF>	+f – sensor height above riverbed
Set Current Staff Gauge Reading	aXGSGR+f!	a+f<CR><LF>	+f – current staff gauge reading, device will calculate sensor height above riverbed as: staff gauge reading + distance from sensor to water
Get Average Time in Seconds for Level	aXGLAV!	a+f<CR><LF>	+f – averaging time in seconds
Set Average Time in Seconds for Level	aXGLAV+f!	a+f<CR><LF>	+f – averaging time in seconds
Get Measurement Unit for Discharge	aXGDUN!	a+d<CR><LF>	+d – measurement unit for discharge 0 – m^3/s, 1 – L/s, 2 – ft^3/s
Set Measurement Unit for Discharge	aXGDUN+d!	a+d<CR><LF>	+d – measurement unit for discharge 0 – m^3/s, 1 – L/s, 2 – ft^3/s

** When the direction filter is set to outgoing (2), the return values will be negative indicating outgoing flow.*

Name	Command	Response	Details
Get Level Filter Type	aXGLFT!	a+d<CR><LF>	+d – filter type for level 0 – no filter, 1 – IIR filter, 2 – Moving average, 3 – Median, 4 – Standard deviation
Set Level Filter Type	aXGLFT+d!	a+d<CR><LF>	+d – filter type for level 0 – no filter, 1 – IIR filter, 2 – Moving average, 3 – Median, 4 – Standard deviation
Get Peak Detector Type For Level	aXGPDT!	a+d<CR><LF>	+d – identifies the peak detector type, can be any of the following: 0 – report the distance to the maximum peak which corresponds to the maximum radar signal reflection 1 - report the last peak which corresponds to the furthest reflection from the radar; this may include multipath reflections in typical cases and should be avoided
Set Peak Detector Type For Level	aXGPDT+d!	a+d<CR><LF>	+d – identifies the peak detector type, can be any of the following: 0 – report the distance to the maximum peak which corresponds to the maximum radar signal reflection 1 - report the last peak which corresponds to the furthest reflection from the radar; this may include multipath reflections in typical cases and should be avoided

Device supports all other commands required by SDI-12 v1.3 and will respond to them but all relevant data can be acquired using the commands from the table above.

8 Dynamic Flow Profiler

The Dynamic Flow Profiler (DFP) is a key feature of the RSS-2-300WL flow meter. It enables the correlation between level and velocity measurements. This correlation is established within the sensor under favourable conditions for both the level and velocity measurements. Sufficient data allows for precise prediction of velocity measurements based on accurate level measurements. By employing DFP, the flow meter generates additional measurement values related to velocity and discharge.

The user can define a range of water levels, referred to as the DFP range, and with a combination of the water level defined for the k-factors, initialize the DFP level points. When properly configured, every level measurement should have a corresponding DFP level point. Velocity measurements are stored for each DFP level point when certain conditions, such as the SNR threshold values for level and velocity measurements, are met. Over time, a certain number of velocity measurements is accumulated for every DFP level point. When the velocity cannot be directly measured due to certain conditions, the flow meter can use these measurements to extract the velocity measurement as a mean value of the past values accumulated for the DFP level point corresponding to the measured water level.

When the velocity measurement SNR in not sufficient, the sensor can use the mean DFP output value (or a percentage of said value) as the main sensor value and use it for discharge calculations. If the measured water level lies between two defined DFP points, the current DFP velocity value is computed using interpolation based on the mean velocities derived from each respective DFP level point.

The DFP velocity values can be used in combination with the current measured velocity value, with each contributing to the final output proportionally based on its designated ratio. For instance, if a ratio of 80 percent is defined, the resultant output value will be composed of 80 percent of the measured value and 20 percent of the DFP value associated with the current water level.

To ensure that the DFP can genetare accurate velocity data, the user must define the operational range of the DFP, i.e. the range in which the water flow is stable, by defining the DFP minimum and maximum levels. By defining the DFP range, the user can optimize the usage of the DFP feature and ensure accurate and reliable velocity measurements within the specified range. It allows for better control over when to rely on the DFP velocity values for discharge calculation, and when to switch to other measurement sources if the water level is outside of the DFP range.

The minimum and maximum DFP levels represent the minimum and maximum water levels for which the DFP will be active. Below the minimum DFP level, the terrain might be rocky or containg other obstacles which would make the velocity measurements unreliable. On the other hand, beyond the maximum DFP level, the flow conditions may change significantly, leading to unreliable velocity measurements. Moreover, the DFP range parameters can be adjusted according to the requirements of the monitoring site. Factors such as channel characteristics, flow dynamics, and environmental conditions can influence the selection of the minimum and maximum DFP levels. Careful consideration and understanding of the hydraulic behaviour of the water system are crucial for effectively utilizing the DFP feature and obtaing accurate velocity measurements used for discharge calculation. This feature enhances the accuracy of discharge calculations and allows for efficient monitoring of water flow dynamics in rivers and channels.

9 Radar Configurator Utility

Geolux provides a user-friendly PC application, Geolux Instrument Configurator, for configuring the surface velocity radar operating parameters. Additionally, the Geolux Instrument Configurator displays measurements.

When started, the Geolux Instrument Configurator displays its main window. Initially, no data is displayed, as the connection to the surface velocity radar is not established.

Picture 7. Geolux Instrument Configurator – Main Window

To connect the Geolux Instrument Configurator with the flow meter, connect your PC to the radar using a serial cable connection. Then, click the *Connect* button in the upper left corner and select *Flow Meter* from the window which appears. In the next window, select the appropriate COM port and interface. If RS-485 interface is selected, additionally select the baud rate and the Modbus ID. In case of multiple devices connected on a single RS-485 bus, make sure that each device has a unique Modbus ID. When the *Connect* button is clicked, Geolux Instrument Configurator will try to establish a data link between your PC and the flow sensor. If the connection is successful, the device will appear under *Connected devices* and the measurements will be displayed in the *Data* tab, Picture 8.

A detailed description of the displayed parameters is available when hovering the mouse over the icon of a specific parameter. Initially, only the most important parameters are displayed while the rest are hidden. By clicking the button with arrows next to the displayed parameters, the user can view all the data received from the device. Clicking the *Start recording data* starts recording the most important data which is initially displayed and saves it to a .csv file.

If RS-232 interface is selected and too many checksum errors are detected, the interface, COM port and baud rate text on the device icon under *Connected devices* will turn red indicating a communication error.

Picture 8. Geolux Instrument Configurator – Data View

Clicking the *Settings* button enables the user to configure the flow meter or upgrade the device to a newer firmware version. The device settings are divided into 3 groups: *Interfaces*, *Processing* and *Measurement* as show in Picture 9. By clicking the name of a specific group, all the settings which belong to that group can be viewed and changed. The following settings are displayed:

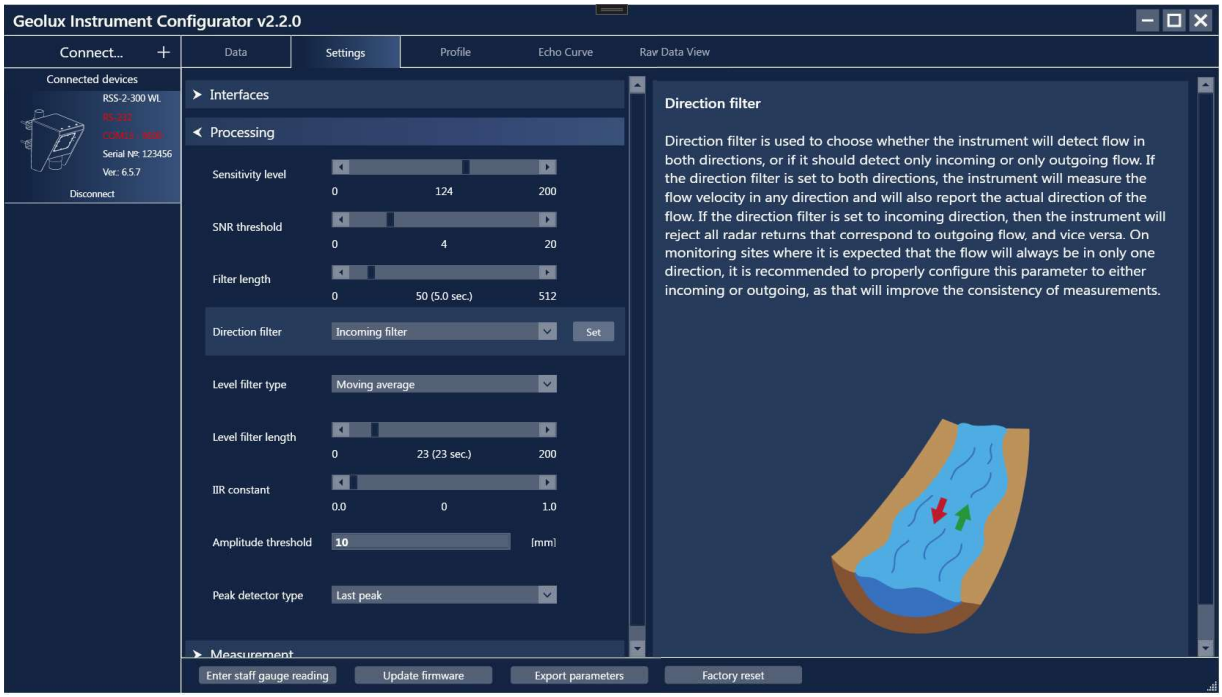
Interfaces
Baud rate
RS-232 protocol
RS-485 protocol
Device ID
Modbus settings
Warm up time
4-20 mA output
4-20 mA min.
4-20 mA max.
Level 4-20 mA min.
Level 4-20 mA max.

Processing
Sensitivity level
SNR threshold
Filter length
Direction filter
Extra fast
Level filter type
Level filter length
IIR constant
Amplitude threshold
Peak detector type

Measurement
Discharge unit
Velocity unit
Level unit
Totalizer unit
Area unit
PGA sensitivity
Velocity min.
Velocity max.
Level active zone min.
Level active zone max.
Level sensor hight
Power management
Totalizer calculation
Totalizer hard save
Dynamic flow profiler
Main output value

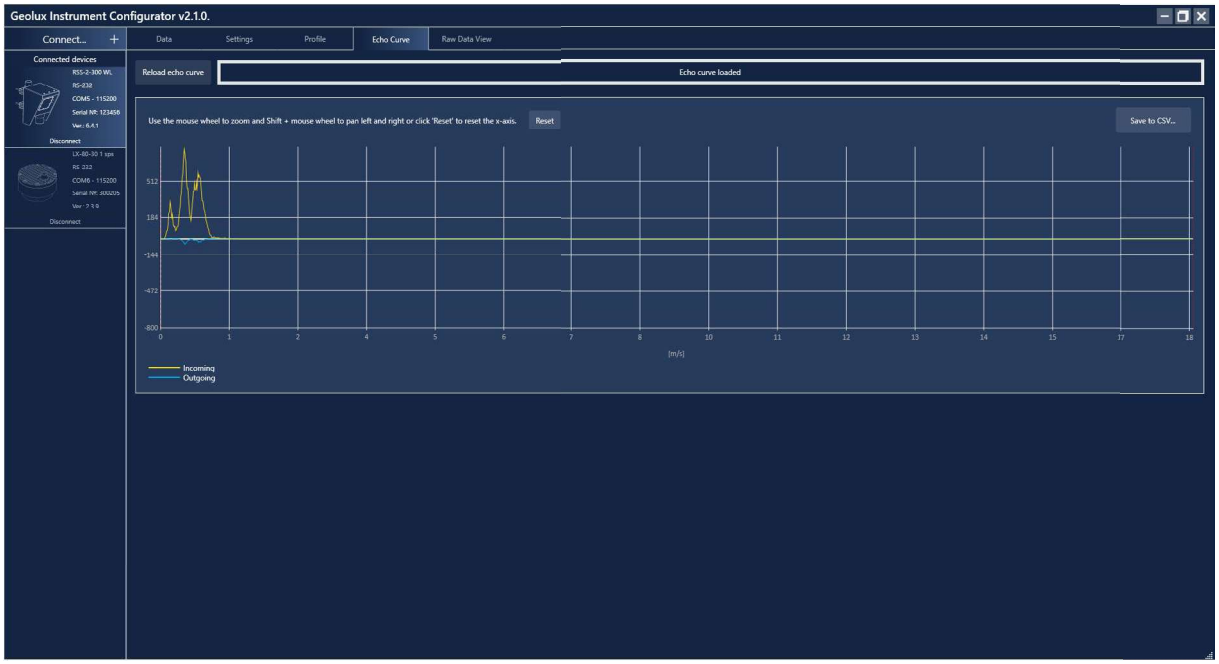
A detailed description (as described in chapter 5 of this user manual) of the selected setting appears on the right side of the window when the user clicks on, or begins to change, a specific setting. When a setting is changed, the *Set* button will appear next to the setting. By clicking the *Set* button, the user confirms the change, and the new settings are saved.

By clicking the *Enter staff gauge* button on the bottom of the *Settings* tab, the user can enter the staff gauge reading if a staff gauge is present on the site. The *Update firmware* button allows the user to update the firmware of the device. The *Export parameters* button exports the current settings to .txt file while the *Factory reset* button reverts all the settings to their default values.



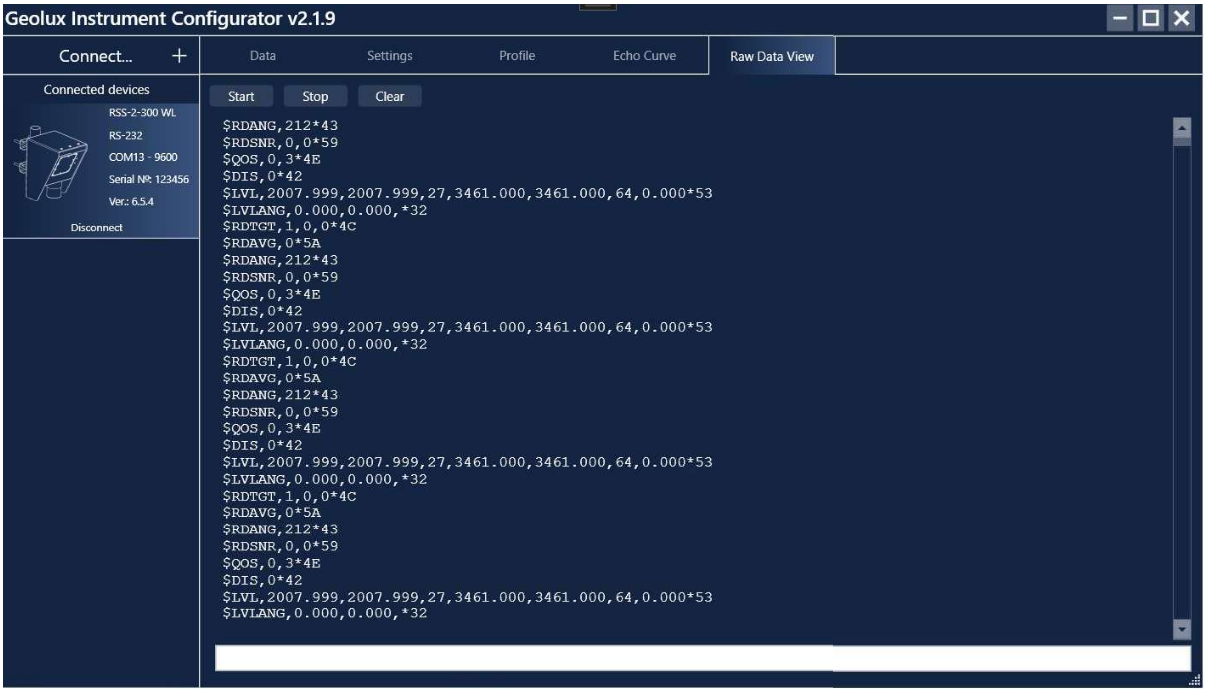
Picture 9. Geolux Instrument Configurator – Settings View

Geolux Instrument Configurator also enables echo curve acquisition. Navigating to the *Echo Curve* tab and clicking the *Load echo curve* button loads the current echo curve. The echo curve plot shows both the incoming and outgoing directions with yellow and blue lines respectively. Depending on the *Direction filter* selected in *Settings*, the echo curve which is not of interest will be shown in grey. If desired, echo curves can be saved to a .csv file.



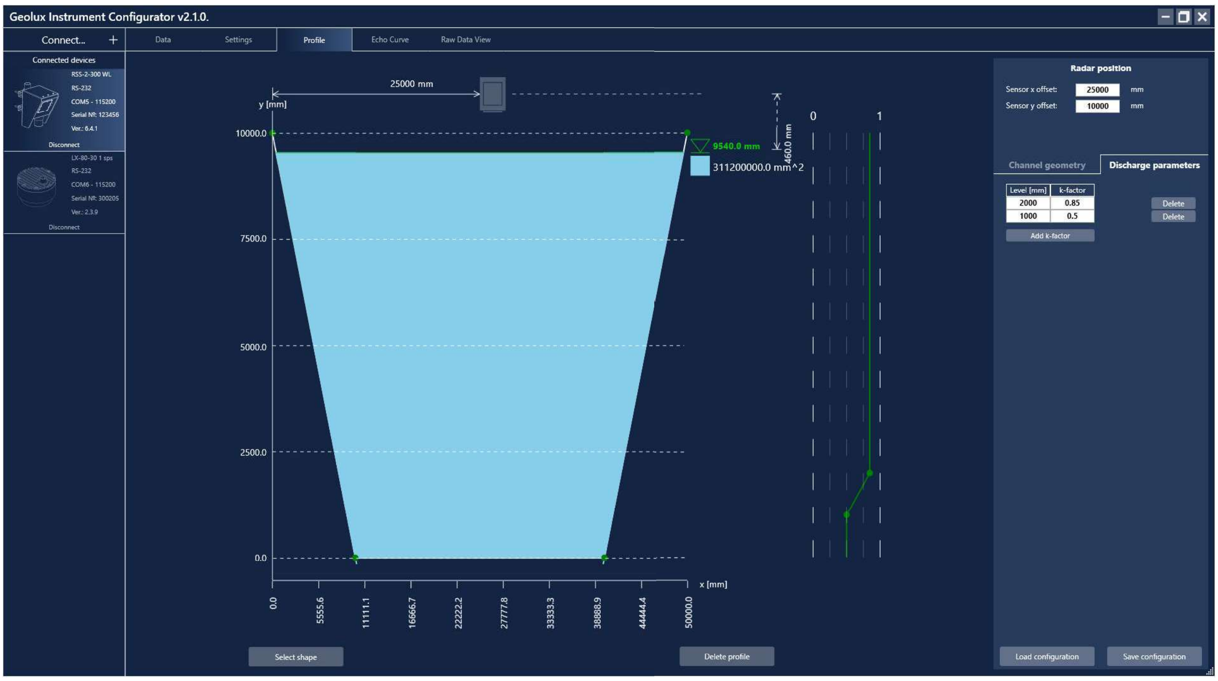
Picture 10. Geolux Instrument Configurator – Echo Curve View

Navigating to the *Raw Data View* tab and clicking the *Start* button enables the user to view the raw data which is being transmitted by the device. Clicking the *Stop* button stops the acquisition of the raw data, while clicking the *Clear* button clears the previously acquired data. The *Raw Data View* tab includes a command line at the bottom so the user can manually send commands to the device.



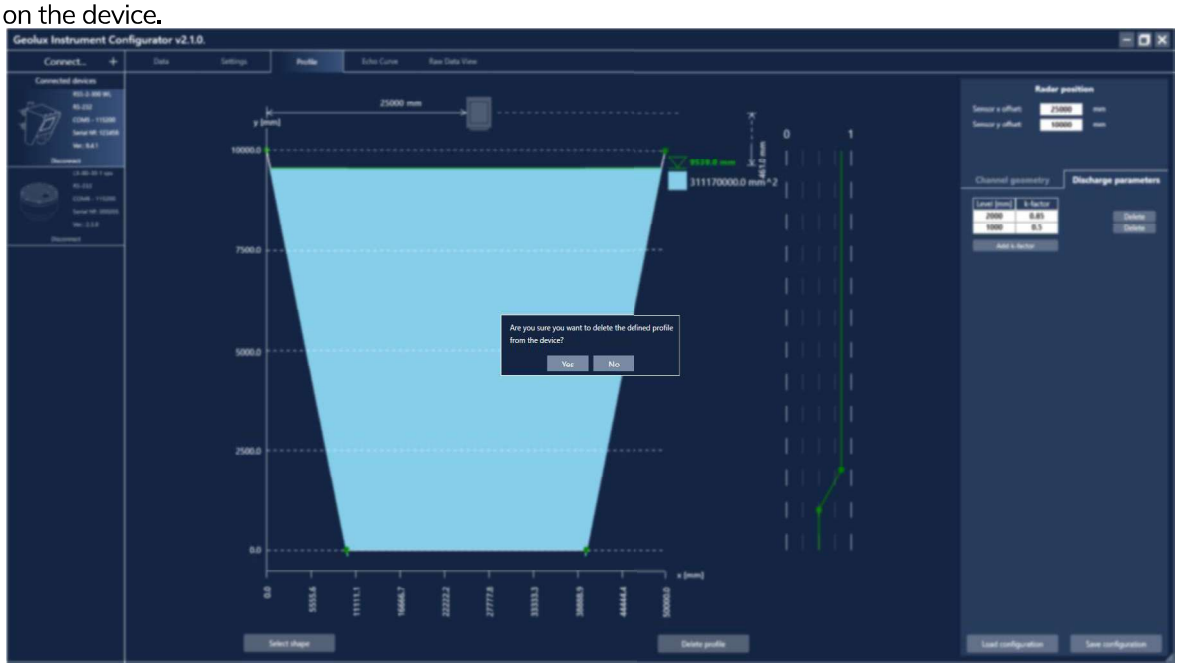
Picture 11. Geolux Instrument Configurator – Raw Data View

Navigating to the *Profile* tab enables the user to define the channel profile geometry and discharge parameters which are used for discharge calculation. If the channel profile geometry is already defined and saved to the device, the existing configuration will be loaded and the profile shape will appear, Picture 12.



Picture 12. Channel Profile Geometry Saved on the Device

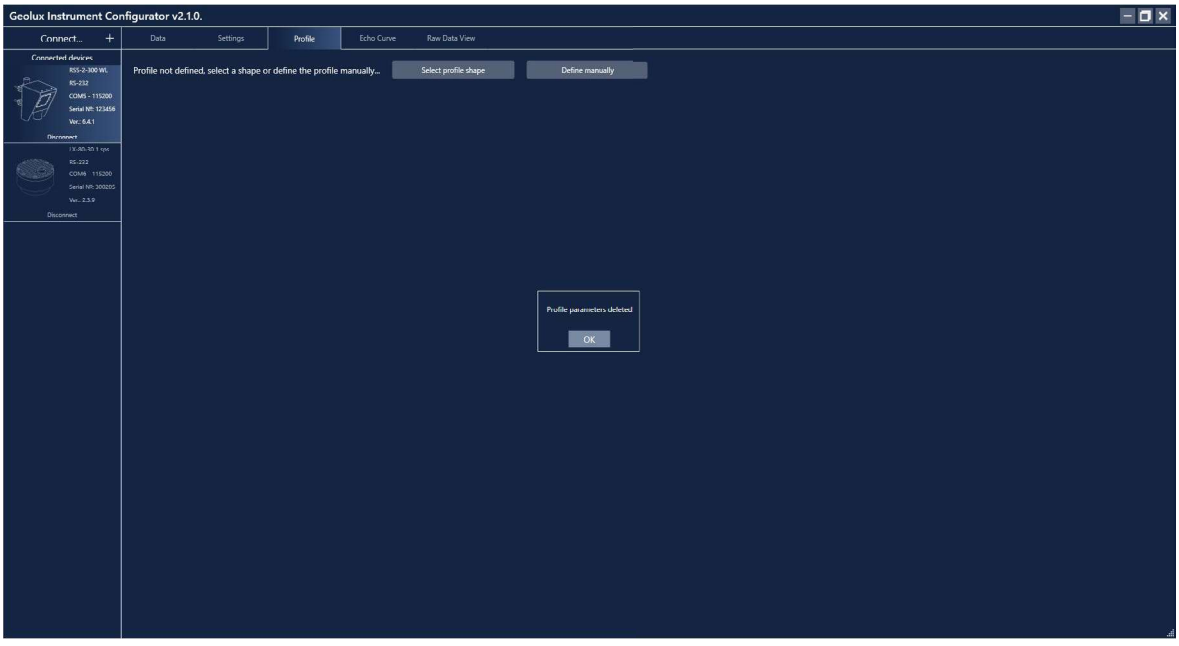
By clicking the *Delete profile* button the user can delete the channel profile geometry which was saved on the device.



Picture 13. Deleting the Existing Channel Profile Geometry

9.1. Configuring the Unit for Discharge Calculation

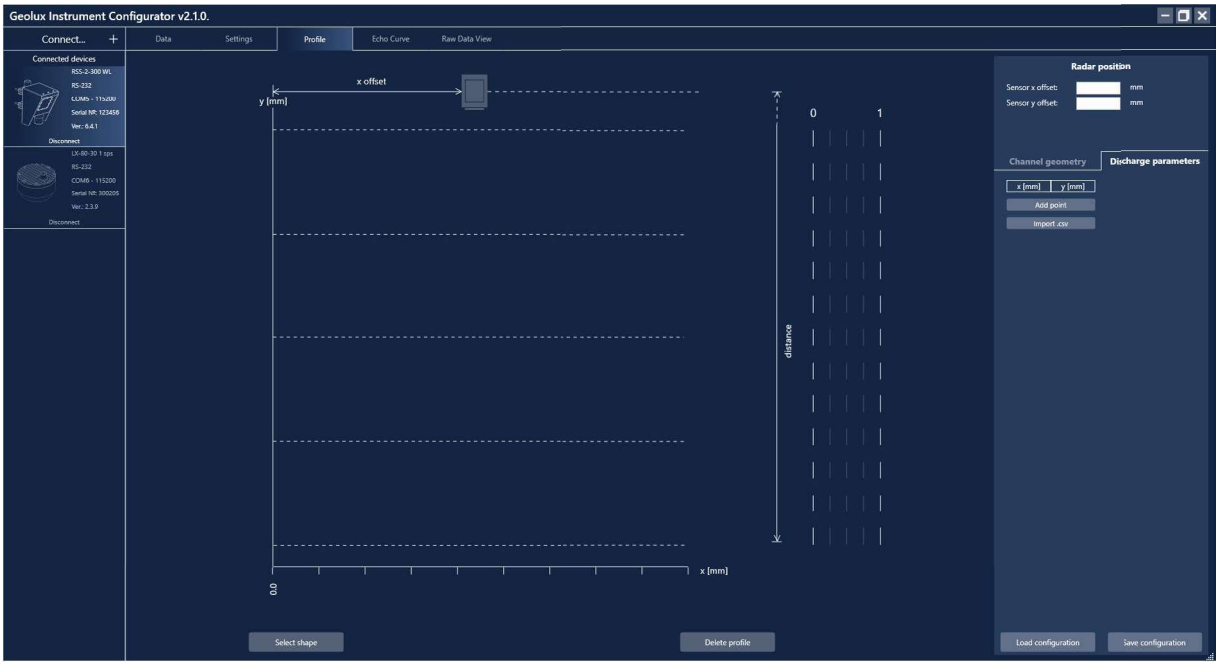
If there is no channel profile geometry saved on the device, or if the user has deleted the defined geometry and wants to define a new one, the geometry can be manually defined, or a predefined shape can be selected to define the channel profile geometry, as described in chapters 9.1.1. and 9.1.2.



Picture 14. Select a Shape or Define the Channel Profile Geometry Manually

9.1.1. Defining the Channel Profile Geometry Manually

After clicking the *Define manually* button, a blank channel profile geometry definition page is shown, as seen in Picture 15.

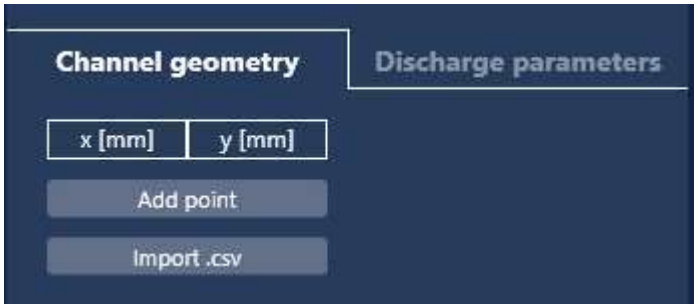


Picture 15. Channel Profile Geometry Definition Page

On the right side of the channel profile geometry definition page, in the *Radar position* section, the user has to input the *Sensor x offset* and *Sensor y offset* of the radar. X offset of the radar is the distance from the leftmost point of the channel to the radar while the y offset represents the distance from the radar to the lowest point of the channel.
After inputting or changing the value, the *Set* button will appear. The user has to click the *Set* button to confirm the change.

Picture 16. Radar Position

After defining the radar position, the channel geometry must be defined. The user can choose to add points by clicking the *Add point* button, or import the geometry from a .csv file by clicking the *Import .csv* button.
If the user chooses to define the channel geometry by adding points, the *Set* or *Delete* button must be selected after inputting the x and y coordinates of a certain point, otherwise the next point cannot be added.

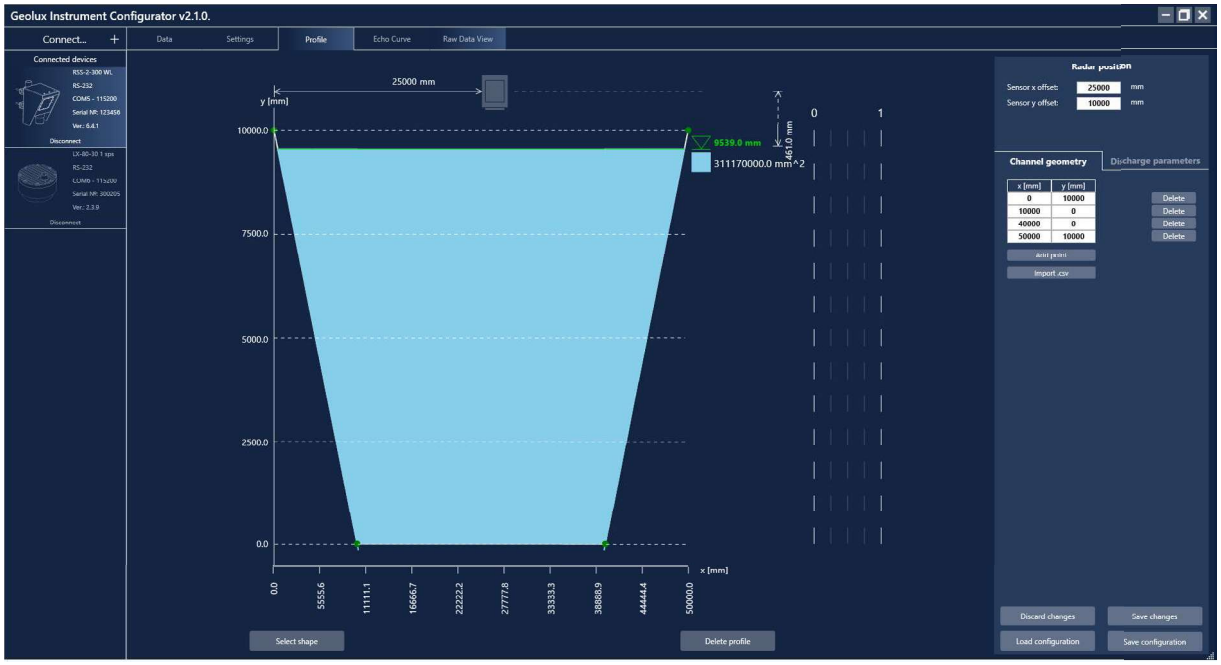


Picture 17. Channel Geometry

If the user has the geometry saved in a .csv file, a preview window with the values from the .csv file will appear as shown in Picture 18. In the preview window the user must select the unit type corresponding to the values. After clicking the *Import* button in the preview window, the channel geometry table will be filled with the values from the .csv file.

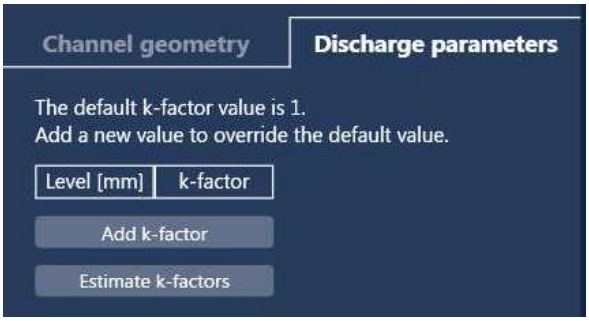
Picture 18. Import .csv File Preview Window

After defining the channel geometry, either by adding points or importing the geometry from a .csv file, the channel profile shape will be drawn on the left side of the channel profile geometry definition page, indicating the sensor position as well as the measured water level and the area of the cross-section that is filled with water.



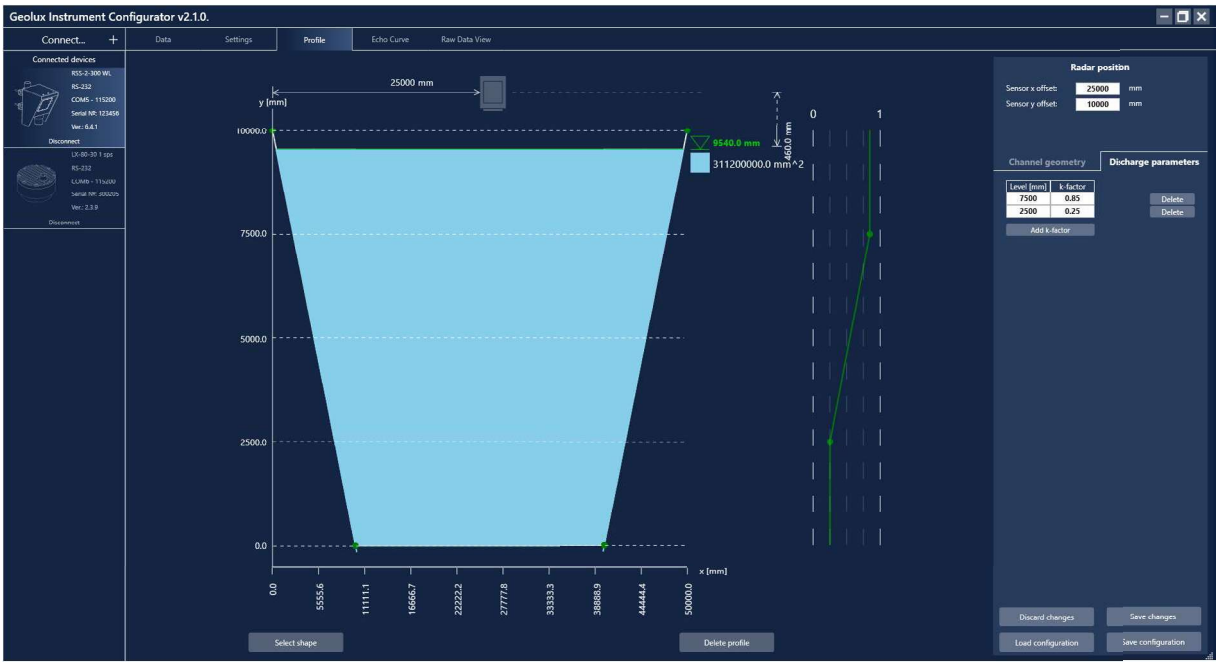
Picture 19. Defined Channel Profile Geometry

The next step needed for discharge calculation is to define the k-factor values. Clicking the *Discharge parameters* button next to the *Channel geometry* button enables the user to input k-factor values corresponding to different water level values by clicking the *Add k-factor* button. The k-factor values can also be estimated by clicking the *Estimate k-factors* button. Estimation of k-factor values will be described in chapter 8.1.3. If the user does not define at least one k-factor value, a default value of 1 will be used for discharge calculation.



Picture 20. Discharge Parameters

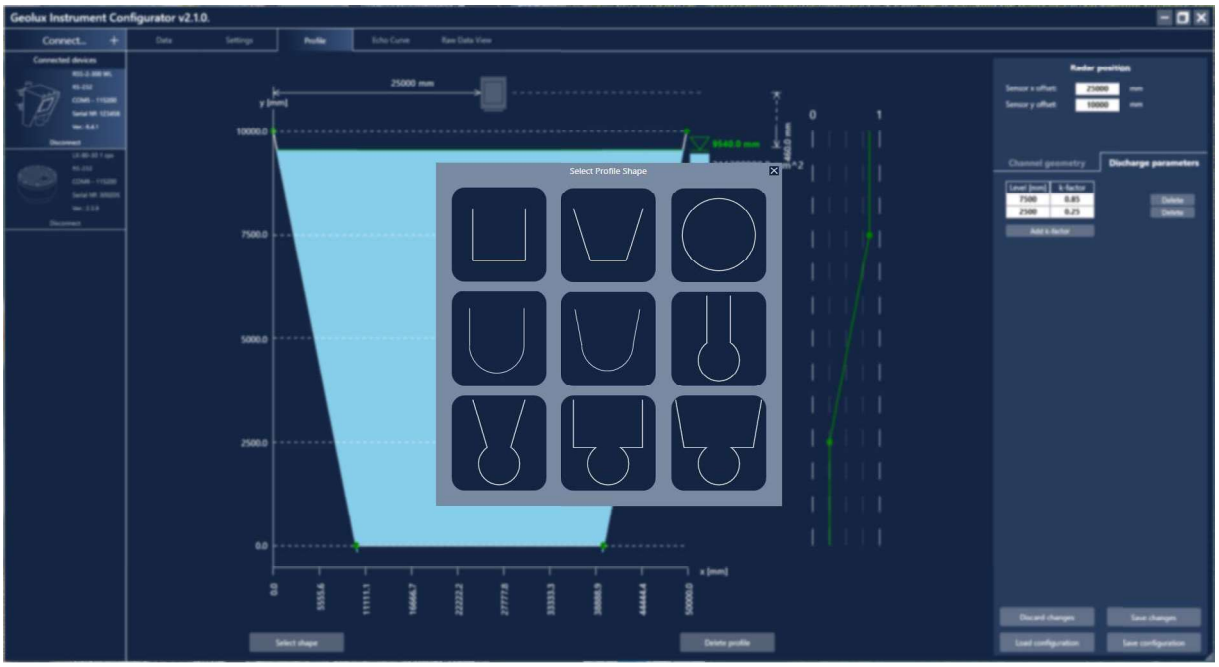
After the discharge parameters have been defined, the values will be drawn on a graph next to the defined channel profile geometry picture.
After defining the channel geometry and discharge parameters, the changes need to be saved to the device. This is done by clicking the *Save changes* button. If the user does not wish to save the changes, clicking the *Discard changes* button will discard all the changes made and load the configuration currently saved on the device. The defined configuration can be saved to the user's computer in the form of an .xml file by clicking the *Save configuration* button. The saved configuration can later be loaded from the created .xml file by clicking the *Load configuration* button and saved to the device by clicking the *Save changes* button.



Picture 21. Defining the Discharge Parameters

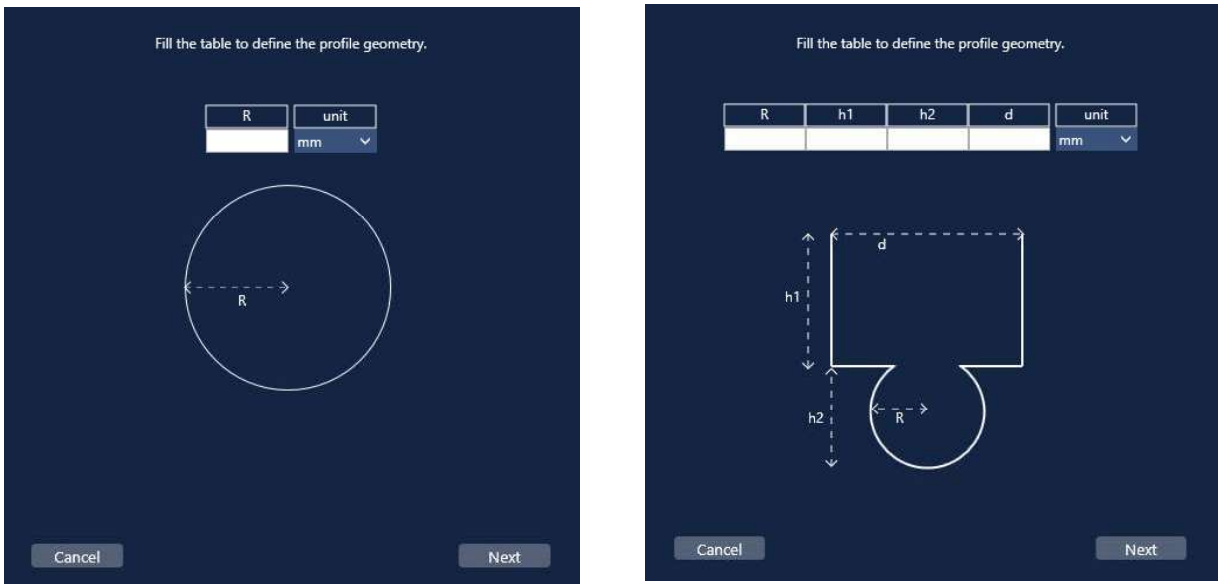
9.1.2. Selecting a Predefined Channel Profile Shape

After clicking the *Select profile shape* button, Picture 14, or *Select shape* button, Picture 21, a new window appears with 9 predefined shapes from which the user can choose.



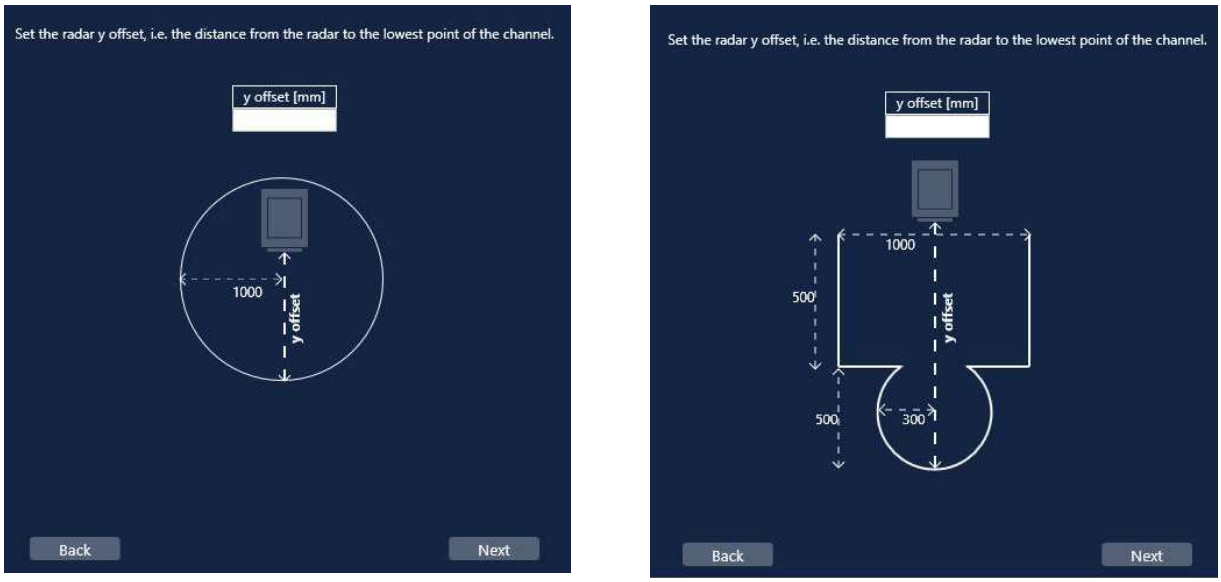
Picture 22. Predefined Shapes

When the user selects a certain shape, a table and a picture of the selected shape appear. The user has to fill the table and select the desired unit. The required values from the table are shown on the picture below the table. The following pictures (23. – 28.) show the definition of 2 different channel shapes.



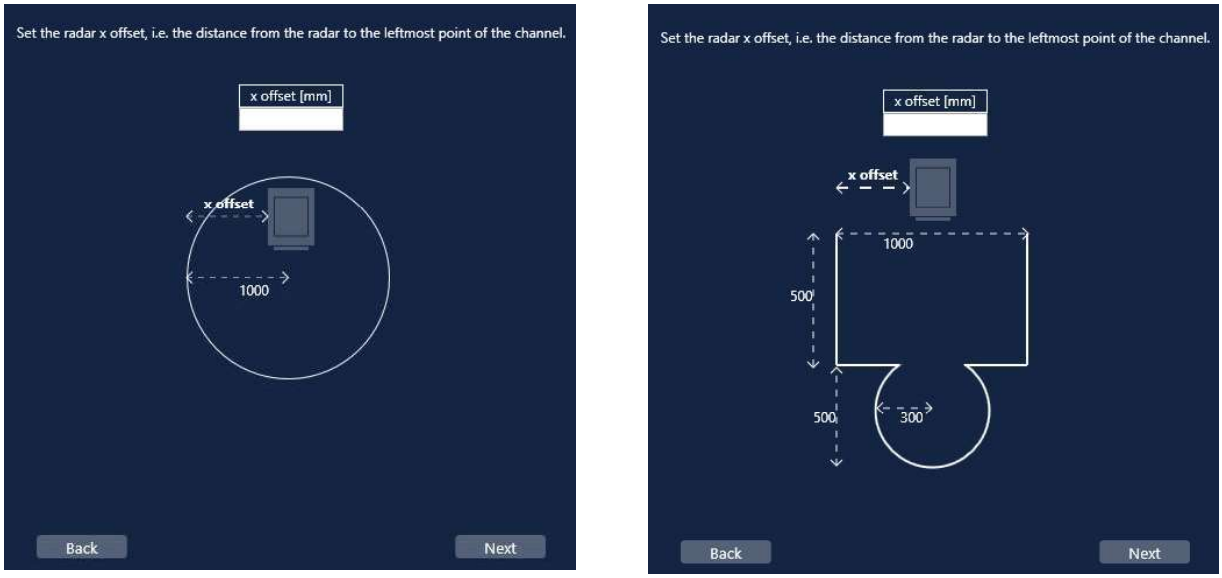
Picture 23. Defining the Channel Geometry of a Predefined Shape

Clicking the *Next* button leads to the next step, i.e. defining the y offset of the radar, Picture 24.
The required y offset distance is clearly show in the picture, as well as the values defined in the previous step. If changes need to be made to the values from the previous step, it can be done by clicking the *Back* button.



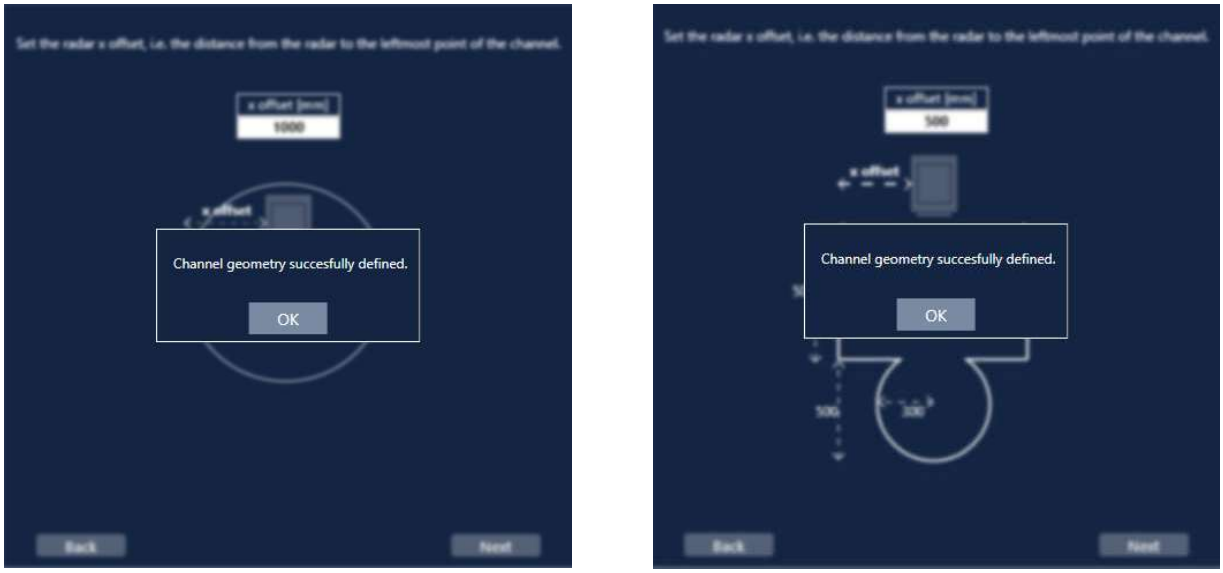
Picture 24. Defining the y Offset of the Radar

The next step is to define the x offset of the radar.



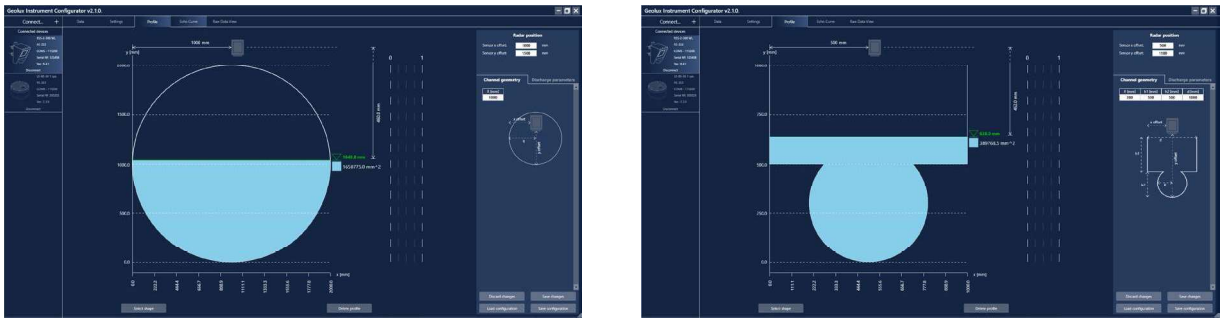
Picture 24. Defining the x Offset of the Radar

Defining the x offset of the radar concludes the channel profile geometry definition.



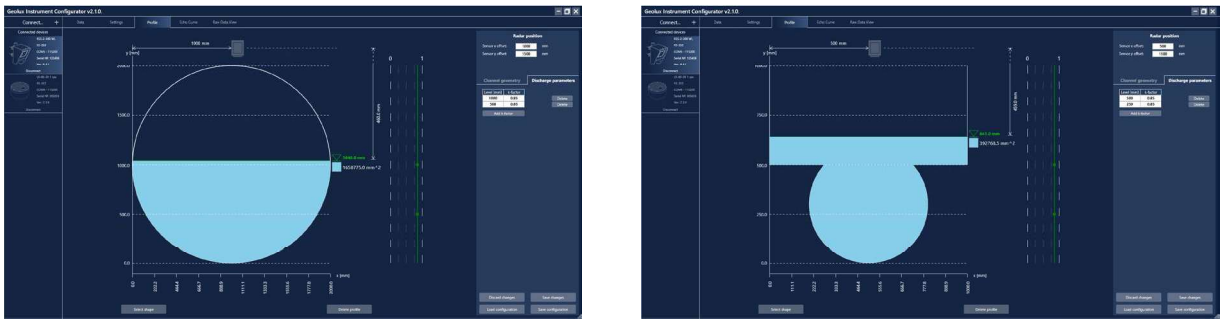
Picture 26. Channel Geometry Defined

After completing all the steps of defining the channel geometry, the selected shape will appear in the Main window, and the *Radar position* and *Channel geometry* sections will be defined by the inputted values.



Picture 27. The Defined Shape Shown in the Main Window

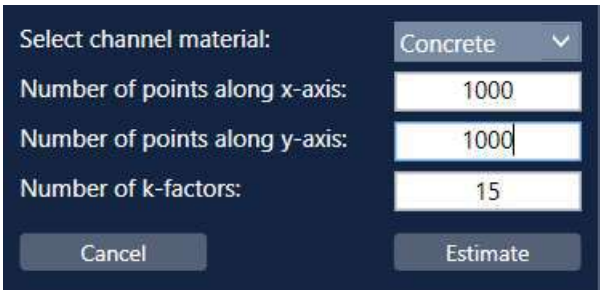
The last step is to define the discharge parameters as described in chapter 8.1.1., Picture 20 or in chapter 8.1.3. After setting the discharge parameters, the values will appear in green on the graph next to the channel geometry picture as seen in Picture 28.



Picture 28. Defining the Discharge Parameters

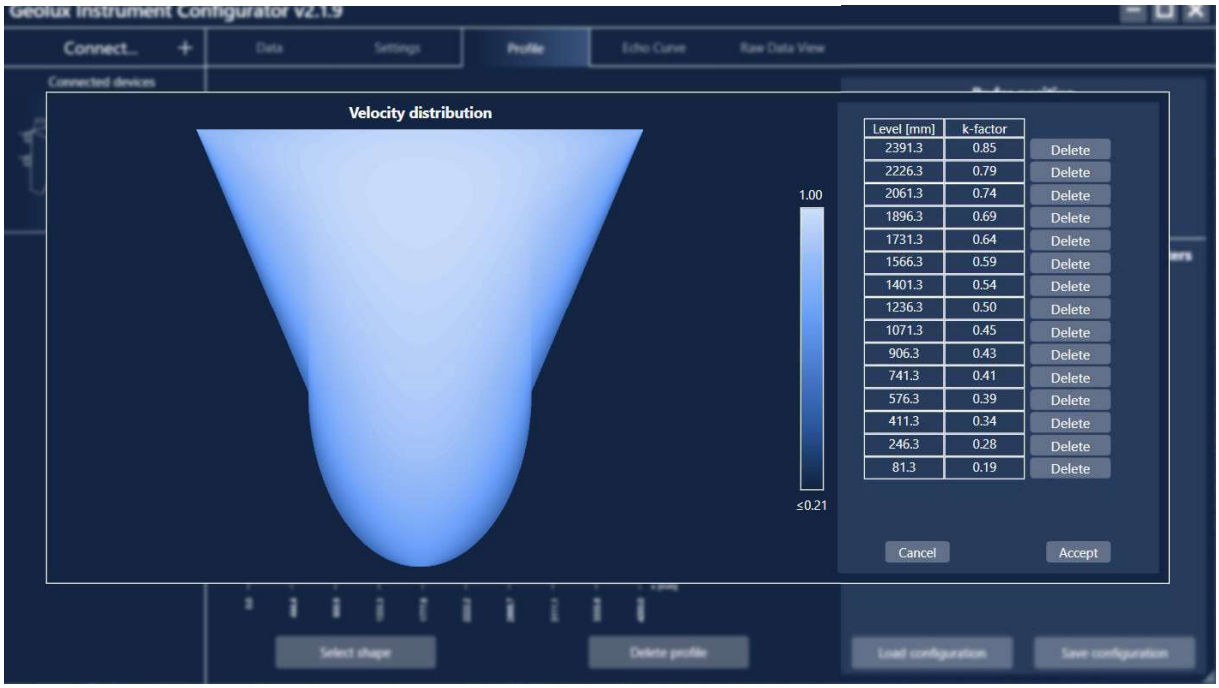
9.1.3. Discharge Parameters Estimation

After clicking the *Estimate k-factors* button, a new window appears (Picture 29.) in which the user can choose from 3 different channel materials - concrete, gravel and grass. The user can also define the mesh used for estimating the velocity distribution i.e. the number of points along the x and y axes, which can be between 100 and 1000 for each axis, as well as the number of k-factor values which will be calculated at depths distributed evenly along the channel profile.



Picture 29. Discharge Parameters Estimation - Input Parameters Window

After clicking the *Estimate* button, the velocity distribution in the channel and the k-factor values at different depths in the channel are calculated. The velocity distribution is represented by a heat map on the left side of the window which appears, while the k-factor values at corresponding levels can be seen on the right side of the window as seen in Picture 30.

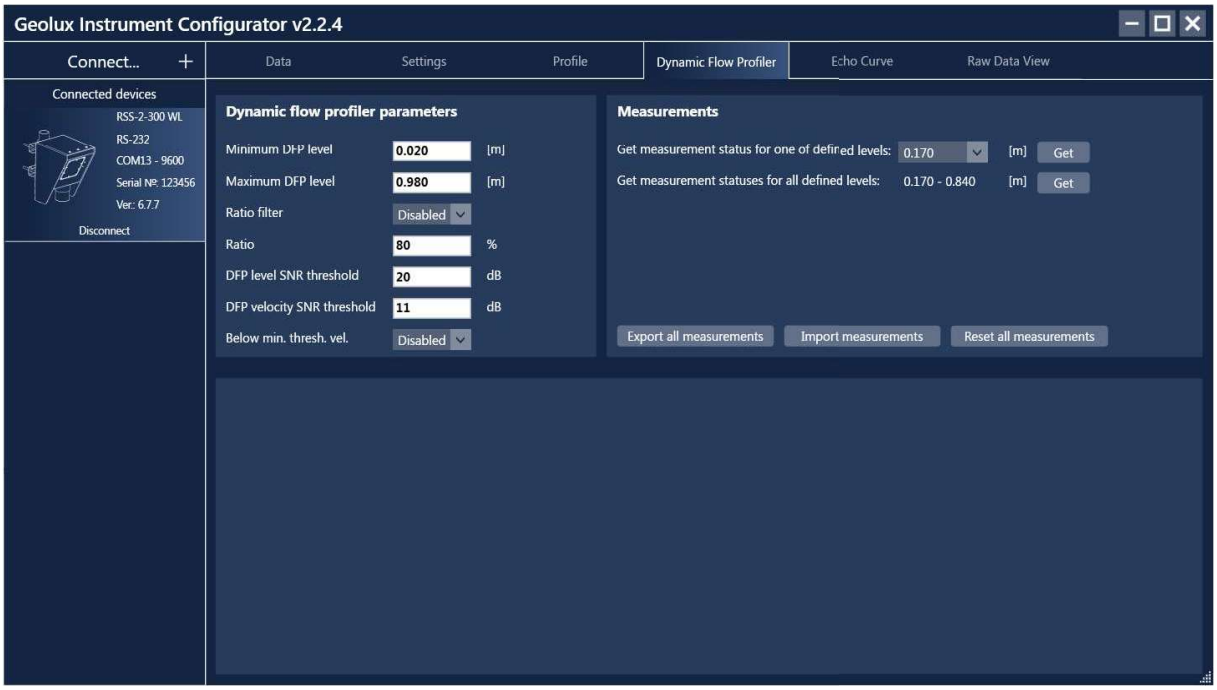


Picture 30. Velocity Distribution and Calculated k-factor Values

After the calculation is performed, the user can choose to delete certain k-factor values before clicking the *Accept* button which returns the user to the *Profile* tab where the discharge parameters can be saved to the device or to an .xml file as described in previous chapters.

9.2. Dynamic Flow Profiler

After defining the channel geometry and the discharge parameters, and if the *Dynamic flow profiler* setting in the *Settings* tab is enabled, the user can navigate to the *Dynamic Flow Profiler* tab, seen in Picture 31, to setup the dynamic flow profiler (DFP) parameters.



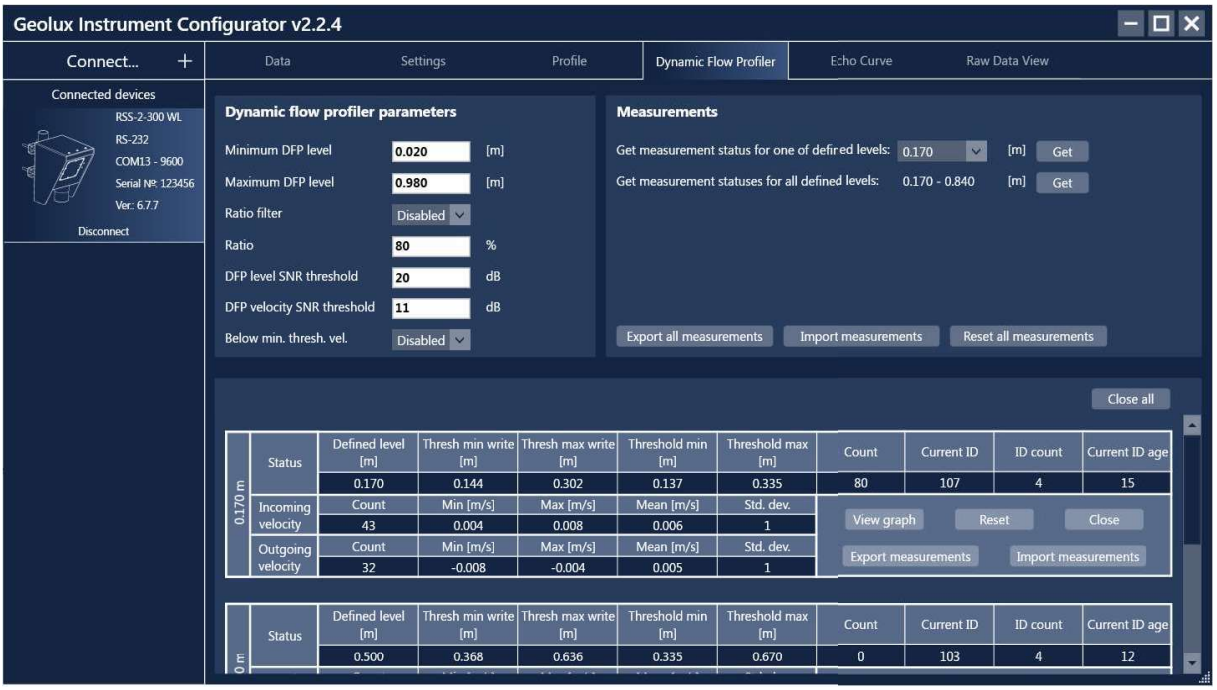
Picture 31. Geolux Instrument Configurator - Dynamic Flow Profiler View

On the left side, in the *Dynamic flow profiler parameters* section, the user can define the dynamic flow profiler parameters such as the DFP range defined by the minimum and maximum level values, the ratio filter settings, and the DFP level and velocity SNR thresholds. A description of each DFP parameter can be viewed by hovering the mouse over the parameter.

9.2.1. Getting the DFP Measurements Status

On the right side, in the *Measurements* section, the user can request the status of saved DFP measurements for each level in the DFP range separately, or for all the levels at once. The levels shown here are the same levels defined in the *Profile* tab in the *Discharge parameters* section. Only the levels which are greater than or equal to the *Minimum level* and less than or equal to the *Maximum level* will be shown. If the discharge parameters are not defined, the DFP functionality cannot be used.

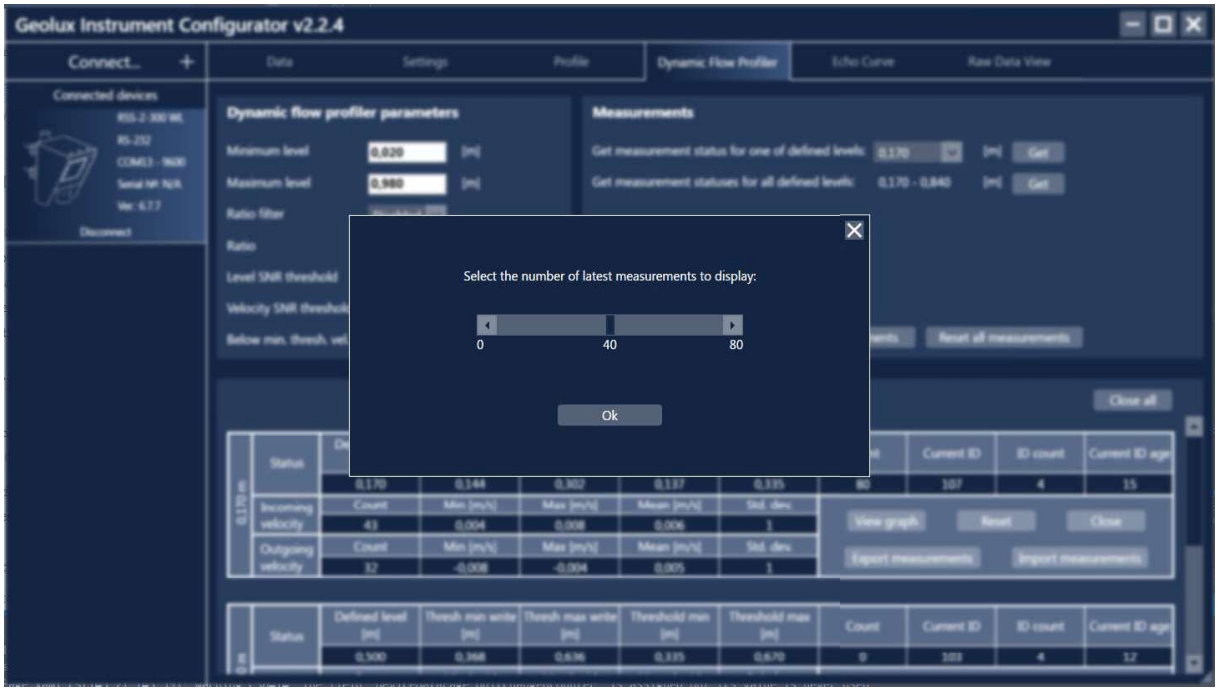
By selecting a level and clicking the *Get* button, or clicking the *Get* button for all levels, the bottom part of the *Dynamic Flow Profiler* tab will be filled with tables containing the measurement status, as seen in Picture 32. A description of the values in the table can be viewed by hovering the mouse above the header of a specific value in the table.



Picture 32. Measurement Status Table

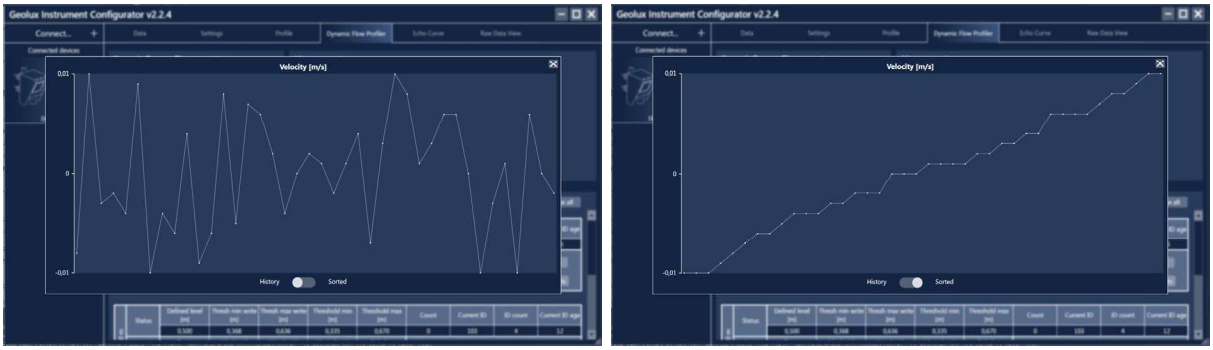
9.2.2. Displaying the Saved DFP Measurements

Once the measurement status table is shown, the user can view a graph of the saved measurements by clicking the *View graph* button in the table and selecting the number of latest measurements to display.



Picture 33. Selecting the Number of Measurements to Display

After selecting the number of latest measurements to display and clicking the *Ok* button, the *History* view of the graph will be shown. The user can toggle between the *History* or *Sorted* views of the graph, as shown in Picture 34.

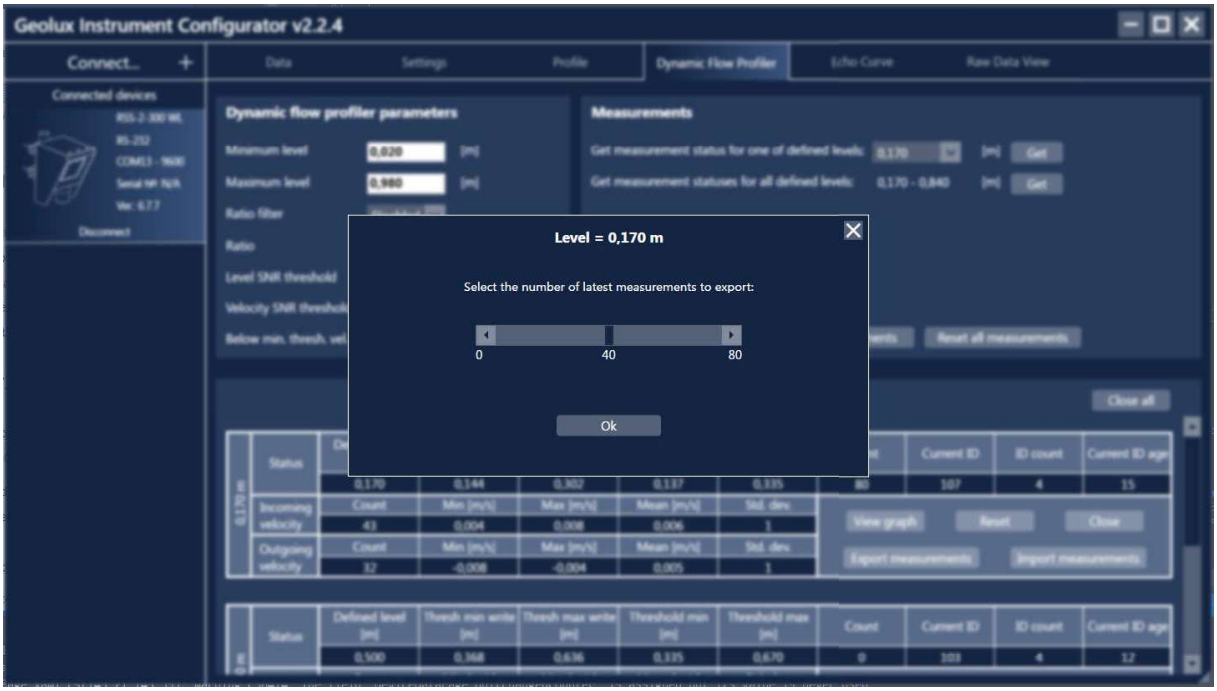


Picture 34. The History and Sorted View of the Latest Measurements Graph

The *History* view of the graph represents the latest measurements in the order in which they were saved while the *Storted* view shows the measurements sorted in ascending order so the user can view the distribution of the measurements more easily.

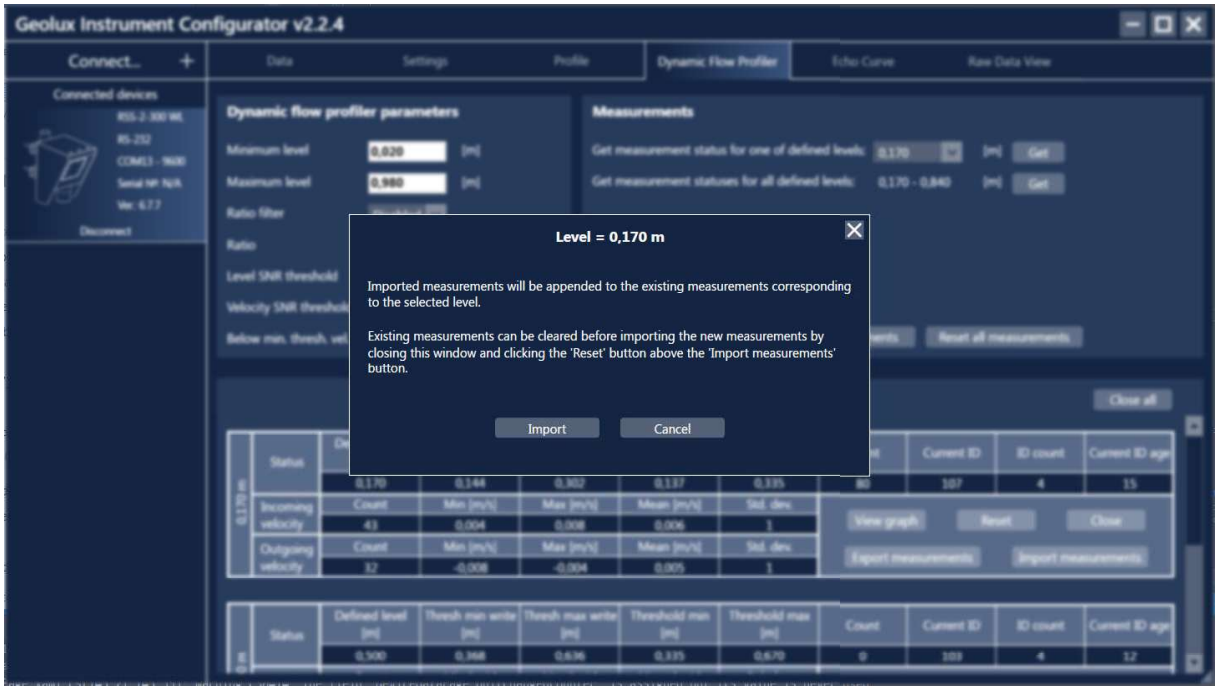
9.2.3. Importing/Exporting Measurements for a Specific Level

By clicking the *Export mesurements* button in the measurements status table, the user can export the saved DFP measurements corresponding to that level to an .xml file by selecting the number of latest measurements to export and clicking *Ok* in the window which appears, Picture 35.



Picture 35. Exporting Measurements for a Specific Level

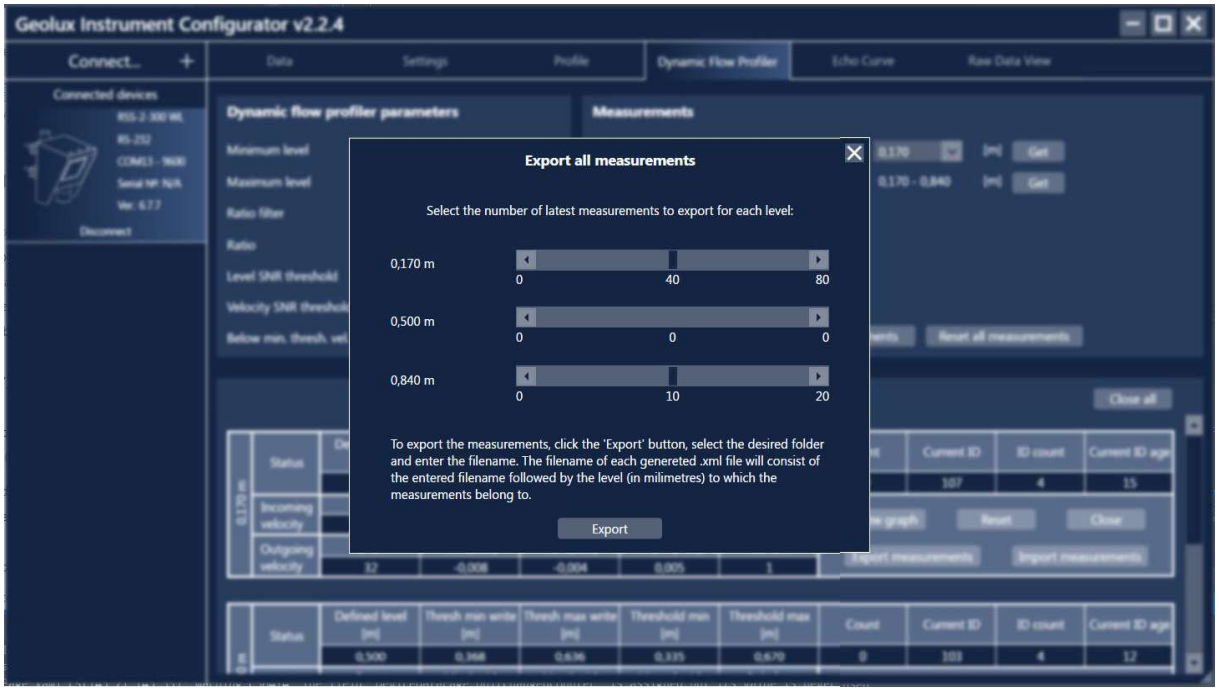
The exported measurements can later be imported by clicking the *Import measurements* button and selecting the appropriate .xml file. Imported measurement will be appended to the existing measurements corresponding to the level defined in the .xml file. Existing measurements can be cleared before importing the new measurements by clicking the *Reset* button in the measurement status table. Be careful when resetting the measurements, it would be wise to export the existing measurements before resetting.



Picture 36. Importing Measurements for a Specific Level

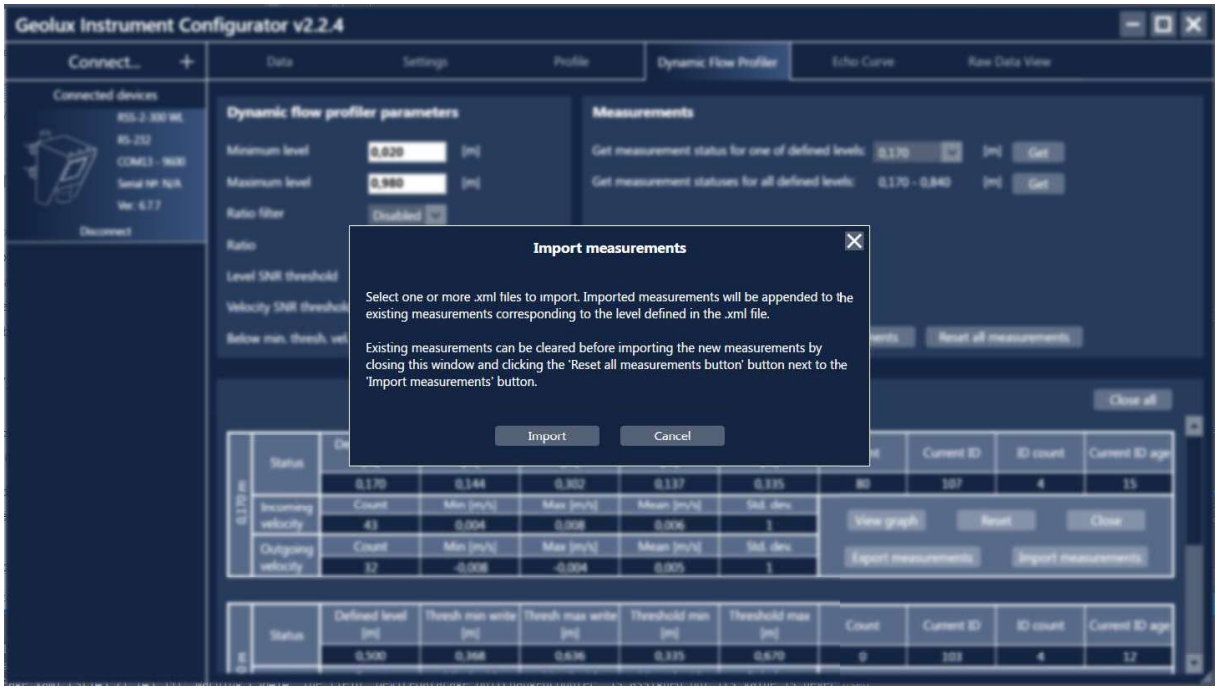
9.2.4. Importing/Exporting Measurements for All Defined Levels

The user can also export the saved measurements for all of the defined levels at once by clicking the *Export all measurements* button in the *Measurements* section of the *Dynamic Flow Profiler* tab. The measurements for each level will be exported to a separate .xml file. In the window which appears after clicking the button (Picture 37), the user can select the number of latest measurements to export for each level individually. After selecting the number of measurements for each level, click the *Export* button, select the desired folder and enter the filename. The filename of each generated .xml file will consist of the entered filename followed by the level (in millimetres) to which the saved measurements belong to.



Picture 37. Exporting Measurements for All Defined Levels

Clicking the *Import measurements* button in the *Measurements* section of the *Dynamic Flow Profiler* tab allows the user to import measurements by selecting one or more .xml files. As in the case of importing measurements for a single level, the imported measurements will be appended to the existing measurements corresponding to the level defined in the .xml file(s). The existing measurements can be cleared before importing the new measurements by clicking the *Reset all measurements* button in the *Measurements* section of the *Dynamic Flow Profiler* tab. Be careful when resetting the measurements, it would be wise to export the existing measurements before resetting.



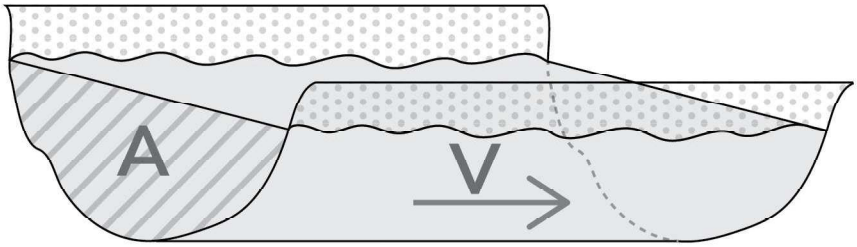
Picture 38. Importing Measurements for Multiple Levels

10 Calculating Discharge from Surface Velocity and Liquid Level

Geolux RSS-2-300WL flow meter measures surface velocity at the water surface and water level. This measurement can be used to calculate actual discharge – the total volume of water that passes through a channel cross-section in a specific period of time. Discharge measurement is important for a wide variety of purposes including flood and pollution control, irrigation, watercourse regulations and broadly as an input data for dimensioning of almost any new structure on the open channel flows.

Discharge is calculated by multiplying mean flow velocity and channel cross-section area. The cross-section area is the area of the slice in the water column made perpendicular to the flow direction.

Let us assume a rectangular channel profile, with constant flow velocity at all points, as seen in Picture 31.



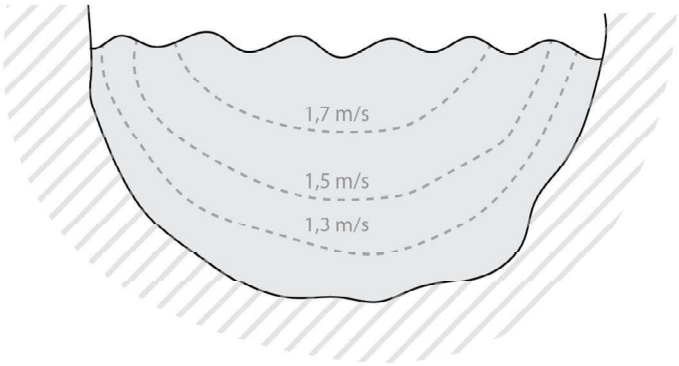
Picture 31. Simple Channel Diagram

The discharge can be calculated according to the formula:

Q=V*A

where Q is discharge (for example in m^3/s), V is flow velocity (for example in m/s), and A is cross-section area (for example in m^2).

For real-world measurements it is important to understand that the velocity of the moving water varies both across the stream channel and from the surface to the bottom of the stream due to friction, as in Picture 32.



Picture 32. Flow Velocity in a Typical Cross-Section

In order to determine the discharge in a realistic channel, the area must be precisely measured by measuring water depths at a series of points across the stream and multiplying by the width of the stream within each segment represented by the depth measurement. The mean cross-section flow velocity needs to be determined from measured surface flow velocity. Studies performed by USGS reveal that, typically, the mean velocity is 80-95% of the surface velocity, the average being 85%.

Knowing non-rectangular area of the stream cross-section, and knowing the surface flow velocity, the following formula can be used:

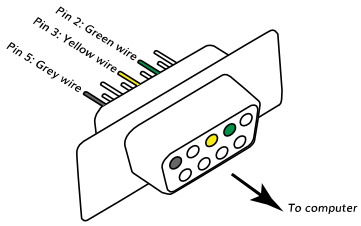
Q=0.85*V*A

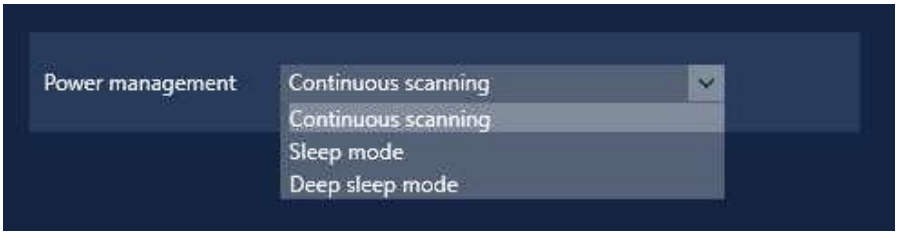
More details about water flow measurements can be found in the following technical note:

https://geolux.ams3.digitaloceanspaces.com/documents/technote3_surface_flow.pdf

11 Troubleshooting

Geolux RSS-2-300WL non-contact open channel flow meter offers multiple data interfaces, in order to make the integration of the device with existing SCADA/telemetry systems easy.

Problem	Possible solutions
The instrument does not connect to the PC application over RS-232 connection.	**1. Make sure that the cable is properly connected to the instrument** Check that the cable M12 circular connector is firmly connected and screwed to the instrument. It is not sufficient to simply attach the cable connector to the instrument connector, the cable connector must be screwed into the instrument connector. **2. Check power supply** Make sure that the power is being supplied to the instrument. A direct-current voltage, between 9 and 27 Volts must be connected to brown (+) and white (-) wires of the instrument cable. The power supply must be able to deliver at least 500 mA of current. **3. Check RS-232 connector** The yellow, green and grey wires from the instrument cable must be properly connected to the serial port on the computer. Make sure that the grey wire (signal ground) is connected – the RS-232 connection will not work if the signal ground is not connected. Also, make sure that the yellow (device Rx) and green (device Tx) are properly connected. If you are using a standard DB9 type connector on the PC computer, the wires should be connected like in the following diagram:  **4. Make sure that you are using the correct COM port** If there are multiple COM ports available on your computer, make sure that you are selecting the correct COM port in the PC application. If you are not certain which COM port number is assigned to the COM port that is being used to establish a connection with the instrument, try setting up the connection with each COM port available in the system, until the connection is established. 

	5. Check that the device is not operating in low power The instrument can be configured to operate in low power mode. While in low power mode, the instrument will not make any measurements but it's communication interfaces will be active. To check whether the instrument is operating in low power mode, check Power management parameter which is available under... and make sure that Continuous scanning is selected.  **6. Make sure that the COM port is not already open** Only one application may use a single COM port in the system. Make sure that no other open application uses the same COM port that you are trying to open. **7. Try restarting the application and/or the computer** Close and reopen the configurator application and try to establish the connection again. Restart your computer and try to establish the connection to the instrument again.
The instrument does not respond over Modbus (RS-485) interface.	**1. Make sure that the cable is properly connected to the instrument** Check that the cable M12 circular connector is firmly connected and screwed to the instrument. It is not sufficient to simply attach the cable connector to the instrument connector, the cable connector must be screwed into the instrument connector. **2. Check power supply** Make sure that the power is being supplied to the instrument. A direct-current voltage, between 9 and 27 Volts must be connected to brown (+) and white (-) wires of the instrument cable. The power supply must be able to deliver at least 500 mA of current. **3. Check RS-485 connector** Make sure that the RS-485 lines on the instrument cable are properly connected to the RS-485 connector. The dark red wire should be connected to D+ line, and the orange line should be connected to D- line. Make sure that the D+ and D- lines are not swapped. Make sure that you have correctly identified and connected the dark red (magenta) wire, as there is also another bright red wire that is used to provide output power for 4-20 mA output. It is possible to misidentify the wire and to connect the bright red wire to D+ instead of dark red wire.

4. Check that you are using the correct slave device ID
The default Modbus device ID is 1. The Modbus device ID can be changed by connecting the instrument to the PC application (over RS-232 connection).

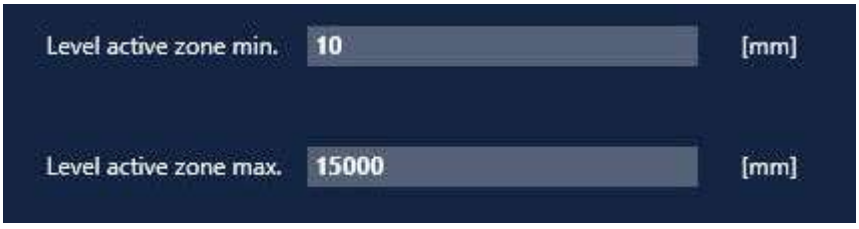
Connect the instrument to the PC using RS-232 connection. Open the Geolux Instrument Configurator application and establish a connection between the instrument and the PC. Then check the *Device ID* parameter and make sure that it is the same as the slave device ID used in issued Modbus requests.

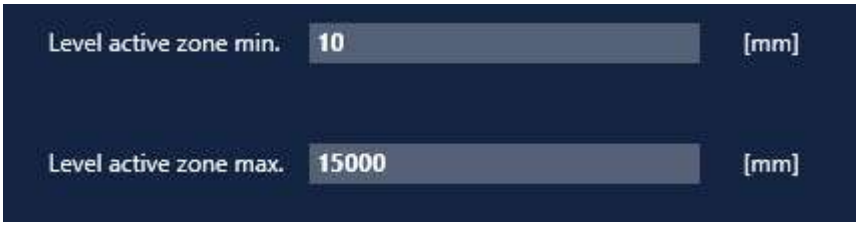
5. Make sure that there are no two devices on the bus with the same Device ID.
Modbus allows to have multiple devices connected on the same bus simultaneously. Each device must have a unique slave device ID assigned, so that the bus master can distinguish between the devices. If two or more devices are assigned the same slave device ID, a bus conflict will happen and prohibit the master to correctly communicate with the slave devices. To resolve this problem, change the instrument's slave device ID to a unique number through the Geolux Instrument Configurator PC application.

6. Check that you are using the correct Modbus connection parameters (baud rate, parity, stop bits)
The default Modbus connection parameters are 9600 bps, even parity, 1 stop bit. These parameters can be changed by connecting the instrument to the PC application (over RS-232 connection).

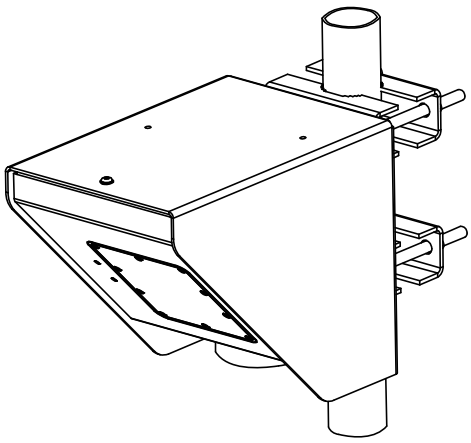
Connect the instrument to the PC using RS-232 connection. Open the Geolux Instrument Configurator application and establish a connection between the instrument and the PC. Then check and verify that all Modbus connection parameters are correct.

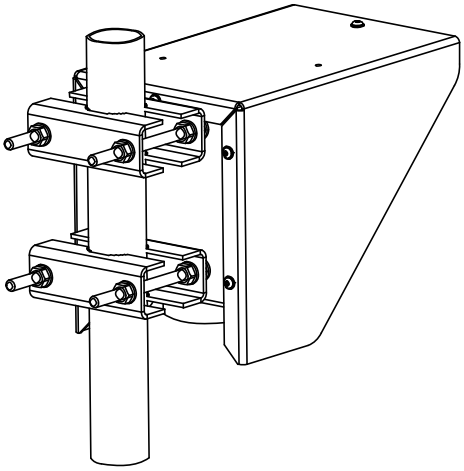
The instrument does not respond over SDI-12 interface.	**1. Make sure that the cable is connected properly to the instrument** Check that the cable M12 circular connector is firmly connected and screwed to the instrument. It is not sufficient to simply attach the cable connector to the instrument connector, the cable connector must be screwed into the instrument connector. **2. Check power supply** Make sure that the power is being supplied to the instrument. A direct-current voltage, between 9 and 27 Volts must be connected to brown (+) and white (-) wires of the instrument cable. The power supply must be able to deliver at least 500 mA of current. **3. Check SDI-12 connection** Check and verify that the red wire from the instrument cable is connected to the SDI-12 data line, and that the grey wire from the instrument cable is connected to the ground (GND) line on the SDI-12 data logger. It is important that both the data line and the signal ground lines are connected.
The 4-20 mA output is not correct.	**1. Make sure that the cable is properly connected to the instrument** Check that the cable M12 circular connector is firmly connected and screwed to the instrument. It is not sufficient to simply attach the cable connector to the instrument connector, the cable connector must be screwed into the instrument connector. **2. Check power supply** Make sure that the power is being supplied to the instrument. A direct-current voltage, between 9 and 27 Volts must be connected to brown (+) and white (-) wires of the instrument cable. The power supply must be able to deliver at least 500 mA of current. **3. Make sure that the wires from the cable are properly connected** For 4-20 mA readout the purple wire (4-20 mA sink output) must be connected to the negative (–) input of the 4-20 mA interface. **4. Check the instrument configuration parameters related to 4-20 mA output** Connect the instrument over RS-232 connection to the Geolux Instrument Configurator application. Check the parameters related to 4-20 mA: 4-20 mA min. and 4-20 mA max. Properly configure these parameters. 

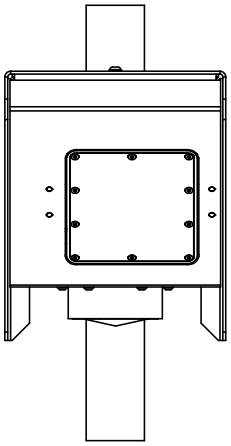
The instrument is operating, but: -it does not report surface velocity measurement, -it reports incorrect measurement -it does not report distance/level measurement, -it reports 0 (zero) distance, -it reports incorrect measurement	**1. Check that the instrument is positioned properly** Make sure that the instrument is installed above the water surface, pointing toward the water surface at a vertical angle. Recommended vertical angle is 45 degrees.  Make sure that the instrument is leveled and pointing towards the water surface at the right angle (the radar beam should be perpendicular to the water surface). Both tilt angles should be zero degrees, or not bigger than 2° in any direction.  **2. Check that there are no obstructions between the instrument and the water surface** There should be no obstructions between the instrument and the water surface, so that the radar waves can freely travel from the instrument's antenna to the water surface and back. Objects such as rocks, construction elements (metal, concrete, etc.), vegetation (tree branches, water vegetation, etc.) can all affect the instrument's reading. If there are some minimal obstructions far away from the water surface, and the radar is reporting the distance to these objects instead of the distance to the water surface, you can adjust the active zone of the instrument. The active zone limits the minimum and maximum range within which the instrument searches for the water surface. For example, if there is an obstruction 1 meter away from the instrument, and the instrument reports a distance of 1 meter, but the water surface is expected to be between 3 and 5 meters, you can adjust the active zone to be within 3 and 5 meters, and then the instrument will discard all measurements outside of that range. 

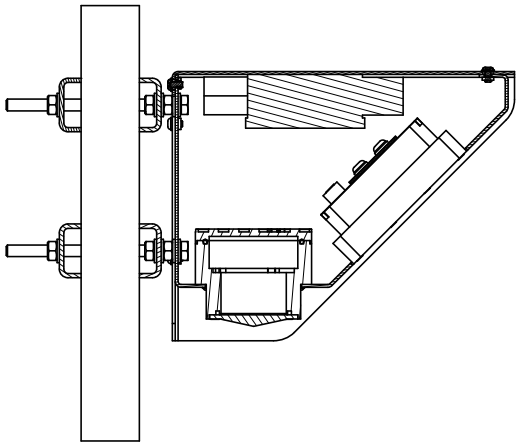
	3. Check that the distance between the instrument and the water surface is within the instrument's operating range. Use a tape measure or a similar tool to measure the distance between the instrument's antenna and the water surface. If the distance to the water surface is greater than the instrument's operational range, the instrument will not be able to measure the distance and the water level. **4. Check that the distance between the instrument and the water surface is within configured active zone.** Connect the instrument to the Geolux Instrument Configurator PC application over RS-232 connection. Check the active zone parameters – if the distance to the actual water surface is outside of the predefined active zone, the instrument will not be able to report the correct distance. Modify the active zone parameters so that the actual distance to the water surface is within the active zone. 

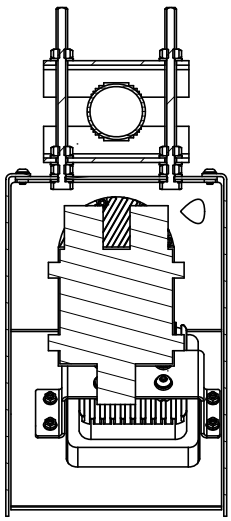
12 Appendix A – Mechanical Assembly

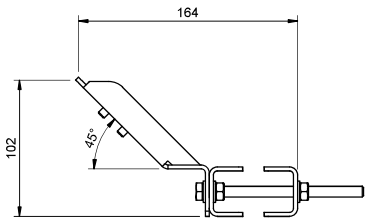


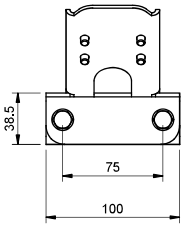


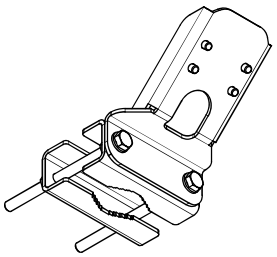


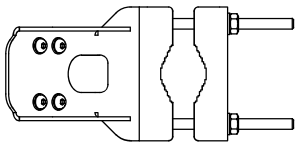


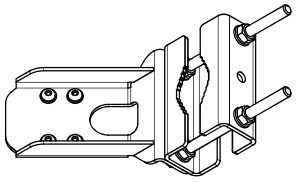


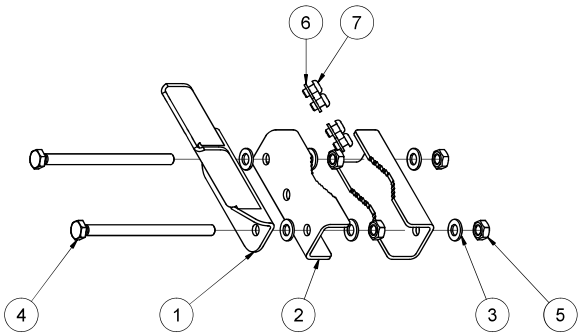


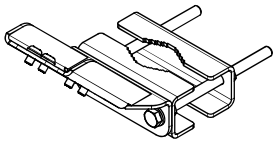












Item	Qty	Part Number	Description	Material
7	4	DIN7380-A4/M6x10	Screw DIN7380 M6x10mm	Stainless Steel
6	4	DIN125-A4/M6	Washer DIN125 M6	Stainless Steel
5	4	DIN934-A4/M8	Nut DIN934 M8	Stainless Steel
4	2	DIN933-A4/M8X120	Screw DIN933 M8x120mm	Stainless Steel
3	6	DIN125-A4/M8	Washer DIN125 M8	Stainless Steel
2	2	GLX2023231-M001	Pole mounting holder 20-60mm	Aluminum 5052
1	1	GLX2017097-M002	Holder for RSS-2-300W with 45° angle	Aluminum 5052

Parts List

DATE	15.09.2023.	
APPROVED	N.O.	
CHECKED	S.M.	
DRAWN	T.G.	

PROJECT RSS-2-300W

TITLE RSS-2-300W Instrument Holder Assembly - 45°

SIZE A2 | DWG NO GLX2023231-A001 | REV RevA

SCALE 1:2 | MATERIAL — | SHEET 1/1

ANNEX NÚM. 2

DATALOGGER. DOCUMENTACIÓ

Finançat per
Unió Europea
Fons Europeu
Next Generation
GOBIERNO DE ESPAÑA
Pla de Recuperació, Transformació i Resiliència
Next Generation Catalunya
Generalitat de Catalunya

4G Datalogger for Weather Station

High capacity datalogger specially designed for use in any type of weather station. The datalogger features 4G communication allowing to send data to the Internet from remote locations.

SKU: HD33MT Category: Dataloggers

Description

High performance technology

High capacity datalogger specially designed for use in any type of weather station. It powers each of the sensors connected and captures the data they provide for subsequent storage, download, processing and online monitoring. The datalogger also allows carrying out statistical calculations with the data registered by the sensors. The LCD display shows different system parameters, such as the active channels, the memory configuration, the battery charge, etc.

Compatible measurements

- Wind speed and direction.
- Temperature and humidity.
- Dew point.
- Soil temperature and humidity.
- Leaf wetness.
- Atmospheric pressure.
- Rain and rain rate.
- Solar, PAR and UV radiation.
- Evaporation.
- Snow depth or water level.
- Visibility and present weather.

- Air and water quality.
- And more.

Compact and weatherproof design

The datalogger features a compact design and is entirely made of corrosion resistant materials to ensure high resistance to weathering. The weatherproof enclosure features a double seal to ensure maximum protection of the electronics from dust, moisture and other external agents.

Maximum connectivity

The datalogger features 4G communication and allows sending data to the Internet from remote locations that do not have their own communication system or staff on site. Additionally, it can be powered from a solar panel and a battery for a total autonomy.

Multitude of applications

Its outstanding versatility makes it ideal for all kind of applications in many fields, the main ones being:

- Meteorology and climatology.
- Hydrology.
- Ports and marinas.
- Stadiums and sports centers.
- Universities and investigation centers.
- Wind, solar and mining farms.
- Railway safety.
- Civil protection.
- Military applications.

Technical specifications

Datalogger specifications

- Capacity: 1 year
- Protocol: MODBUS-RTU, HTTP, FTP and email

Electrical specifications

- Power supply voltage: 7 to 28 VDC
- Power consumption: 1 A (max.)
- Input signal: 4 x analog, 2 x digital, RS-485 and SDI-12
- Output signal: 2 x alarms, RS-485, USB and 4G

Mechanical specifications

- Working temperature: -40°C to 70°C

- Material: high strength plastic
- Dimensions: 170 x 270 x 110 mm
- Weight: 1 Kg

English

Operating manual

Weather station data logger

HD33[L]MT.4

Keep for fut re reference.

INDEX

1 INTRODUCTION

The HD33[L]MT.4 data logger is specifically designed for use in weather stations. Many types of sensors can be connected thanks to its standard terminal header inputs. The data logger is equipped with:

- 4 analog independently configurable inputs (0…50 mV, -50…+50 mV, 0…1 V, 0…10 V, 0…20 mA or 4…20 mA, Pt100, Pt1000, thermocouple, potentiometer, pyrgeometer).
- 2 voltage-free counting contact inputs (e.g. a tipping bucket rain gauge and a cup anemometer can be connected).
- One RS485 port with **Modbus TCP/IP** (via an **optional** module for the connection to an ETHERNET network) or Modbus-RTU protocol, configurable as "Master" or "Slave".
- One SDI-12 "Master" port compatible with version 1.3 of SDI-12 protocol.
- 2 voltage-free contact alarm outputs.

On request, input with M12 connector for relative humidity and temperature with NTC sensor combined probe or, alternatively, for temperature only probe with NTC sensor.

Optional custom LCD display.

Thanks to 4G / 3G / GSM(2G) / GPRS transmission, the user will not have to remove the data logger from its position or reach the place where the data logger is installed to download the data measured with the PC: the instrument can send the data via **e-mail** or **FTP** and can upload the data on an **HTTP** server (**Cloud**, for example the Delta OHM portal "**www.deltaohm.cloud**"). The data logger can be controlled remotely either by sending commands via SMS messages or by establishing a direct TCP/IP connection via mobile network with a remote PC connected to the Internet.

For each detected quantity, the user can set two alarm thresholds (high threshold and low threshold), the alarm hysteresis and a delay in the generation of the alarm. The overrun of the thresholds can be signaled by alarm e-mails or SMS messages. Two voltage-free contact alarm outputs are also available.

HD35AP-S PC software, downloadable free of charge from the Delta OHM website, allows configuration of data logger, displaying measurements in real time both in graphical and numerical format, data download. The data transferred to the PC are entered into a database.

The internal clock of the data logger has high accuracy and is extremely stable in the whole operating temperature range of the instrument. It supports the **automatic time synchronization** with an HTTP reference server.

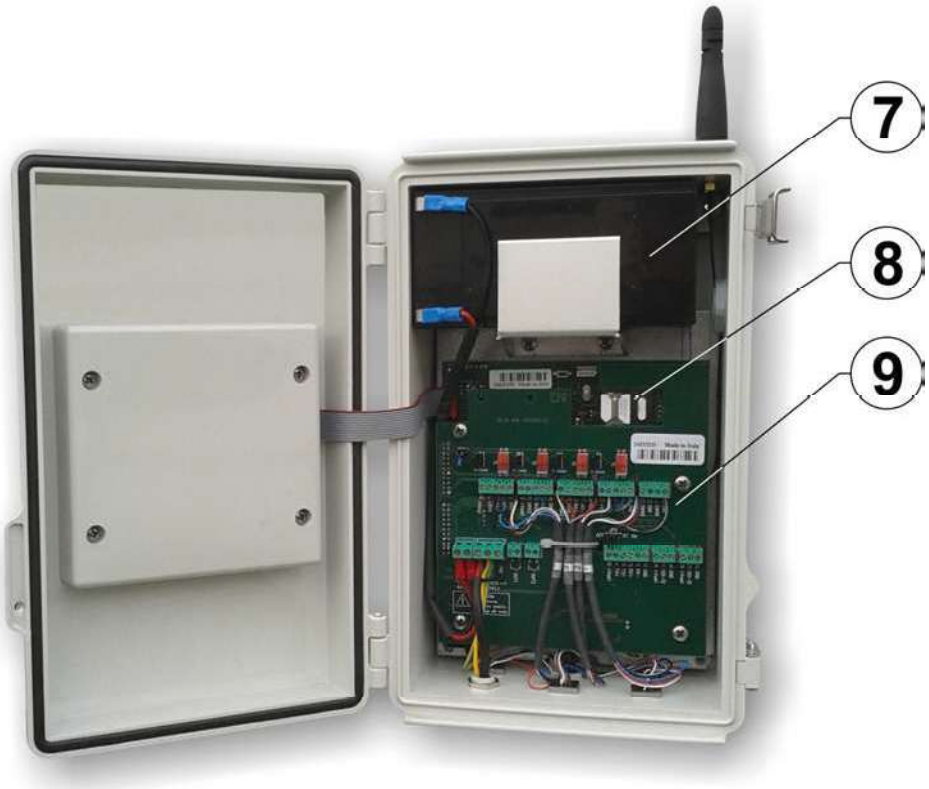
The **optional** 12 V / 3.4 Ah rechargeable backup battery to be installed inside the case prevents the loss of recordings in case of no external power supply. The battery charger is integrated in the instrument. The data logger can be powered by a solar panel and is designed to be **low power**: can operate for weeks even in absence of battery recharging from the solar panel. Power supply 18…30 Vdc if the rechargeable battery is used or 7…30 Vdc (without ETHERNET module) / 12…30 Vdc (with ETHERNET module) if the rechargeable battery is not used.

A switched power supply output allows powering the sensors only when measurements have to be taken.

IP 65 housing.

2 DESCRIPTION

1. Cable glands, connectors and USB port with mini-USB connector
2. Housing closing hooks
3. Antenna
4. Housing cover
5. LCD (optional)
6. Push-buttons
7. Battery (optional)
8. SIM holder
9. Internal terminal header



3 TECHNICAL CHARACTERISTICS

Power supply	If the rechargeable battery is used: 18…30 Vdc If the rechargeable battery is not used: 7…30 Vdc without ETHERNET module 12…30 Vdc with ETHERNET module
Power consumption @ 12 Vdc	< 4 mA without ETHERNET module and with no mobile network activity ~ 200 mA with ETHERNET module and with no mobile network activity < 1 A peak during mobile network activity
Battery	Optional internal lead 12 V / 3.4 Ah. Maximum charge current 1 A. The autonomy depends on the number and type of sensors connected.
Switched power supply output	If the data logger is powered by a solar panel (+Vpanel input), the output is equal to the voltage of the internal lead battery (nominal 12 V). If the data logger is powered by the +Vdc input, the output is equal to the voltage of the +Vdc input. The output is active only when the external sensors have to be powered.
Antenna	External
Measuring interval	1, 2, 5, 10, 15, 30 s / 1, 2, 5, 10, 15, 30, 60 min
Logging interval	1, 2, 5, 10, 15, 30 s / 1, 2, 5, 10, 15, 30, 60 min
Internal memory	Circular management or stop logging if memory is full. Number of samples: from 242,850 to 858,070 depending on the number of detected quantities.
Alarm	Sending of alarm e-mail and SMS. Two voltage-free normally open (NO) contact alarm outputs. Max 300 mA @ 30 Vdc resistive charge.
Display	Optional custom LCD
LED indicator	2-color LED: power on (blinks red), mobile network activity (blinks green)
Connection to PC	USB port with mini-USB connector
ETHERNET connection	RJ45 connector (only if the optional ETHERNET module is present)
Internal clock drift	± 2 ppm (0…+40 °C) / ± 5 ppm (-40…+70 °C)
Operating conditions	-40…+70 °C / 0…100 %RH for the version without LCD -20…+70 °C / 0…100 %RH for the version with LCD
Connectors for external probes	M12 connectors or cable glands
Weight	2.8 kg approx.
Housing	Dimensions: 270 x 170 x 110 mm (excluding external antenna) Material: Polycarbonate (PC) Protection degree: IP 65 (with protective cap on the USB connector)
Installation	Fixing to a max. 60 mm diameter mast.

Measurement characteristics:

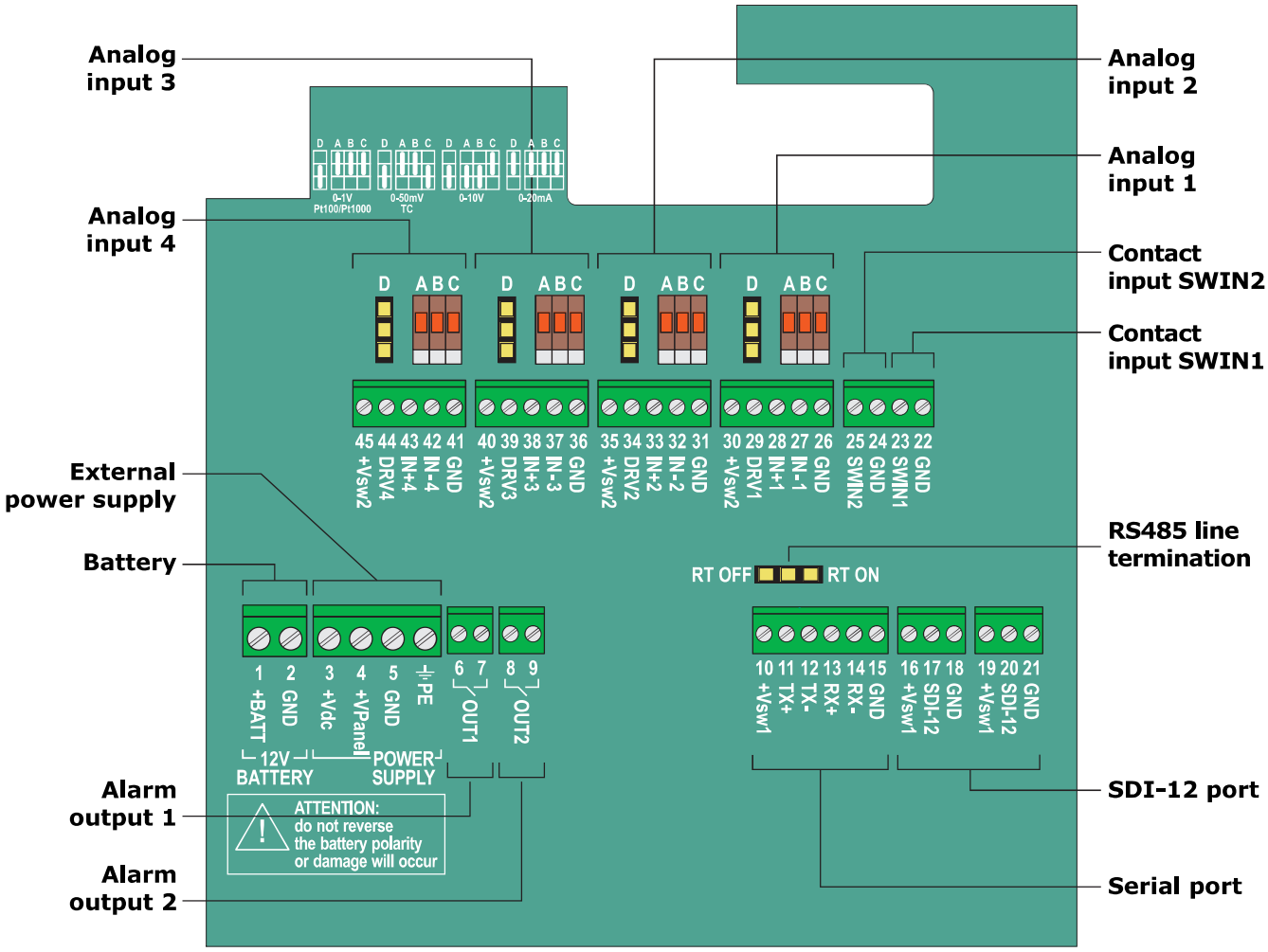
Temperature (*instrument in line with the probe HP3517WTC… or TP350NTC…*)	
Sensor	NTC 10 kΩ @ 25 °C
Measuring range	-40…+105 °C
Resolution (of instrument)	0.1 °C
Accuracy	± 0.3 °C in the range 0…+70 °C / ± 0.4 °C outside
Stability	0.1 °C / year
Relative Humidity (*instrument in line with the probe HP3517WTC …*)	
Sensor	Capacitive
Measuring range	0…100 %RH
Resolution (of instrument)	0.1 %
Accuracy	± 1.8 %RH (0…85 %RH) / ± 2.5 %RH (85…100 %RH) @ T=15…35 °C ± (2 + 1.5% measure)% @ T=remaining range
Sensor operating temperature	-40…+80 °C
Response time	T_{90} < 20 s (air speed = 2 m/s, without filter)
Temperature drift	±2% over the whole operation temperature range
Stability	1% / year
Calculated quantities	Dew Point
For the measurement of relative humidity and temperature, the combined probe **HP3517WTC…** with NTC 10KΩ @ 25 °C temperature sensor is used, if requested. Alternatively, to the same input can be connected the temperature only probe **TP350NTC….** The outdoor installation of the combined temperature and relative humidity probe requires HD9007A-1 or HD9007A-2 protection against solar radiations. **Replacement of the humidity probe requires recalibration of the instrument in line with the new probe.**	
Atmospheric pressure (*optional internal sensor*)	
Sensor	Piezoresistive
Measuring range	300…1100 hPa
Resolution (of instrument)	0.1 hPa
Accuracy	± 0.5 hPa (800...1100 hPa) @ T=25°C ± 1 hPa (300...1100 hPa) @ T=0...50°C
Stability	1 hPa / year
Temperature drift	±3 hPa tra -20…+60 °C
Pt100/Pt1000	
Measuring range	-200…+650 °C
Resolution	0.1 °C
Accuracy	± 0.1 °C (excluding probe error)
Sensor coefficient	α=0.00385 $°C^{-1}$
Connection	2, 3 or 4 wires
Thermocouple	
Thermocouple type	K, J, T, N, E. The inputs are not isolated, **use thermocouples with isolated hot junction.**
Measuring range	type **K**: -200…+1370 °C type **J**: -100…+750 °C type **E**: -200…+750 °C type **T**: -200…+400 °C type **N**: -200…+1300 °C
Resolution	0.1 °C
Accuracy (excluding probe error)	type **K**: ± 0.1 °C (< 600 °C) type **E**: ± 0.1 °C (< 300 °C) ± 0.2 °C (> 600 °C) ± 0.2 °C (> 300 °C) type **N**: ± 0.1 °C (< 600 °C) type **J**: ± 0.1 °C ± 0.2 °C (> 600 °C) type **T**: ± 0.1 °C

0/4...20 mA input	
Shunt resistance	Internal (50 Ω)
Resolution	16 bit
Accuracy	± 2 µA
Inputs 0...50 mV / -50...50 mV / 0...1 V / 0...10 V	
Input Resistance	100 MΩ
Resolution	16 bit
Accuracy	± 0.01% f.s.
Inputs for counting the switchings of a voltage-free contact	
Switching frequency	50 Hz max.
Hold Time	10 ms min.
Potentiometer input	
Potentiometer	Typically 10 kΩ
Resolution	16 bit
Accuracy	± 0.01% f.s.
Rainfall measurement	

The data logger can record:

- Maximum rainfall rate
- Daily rainfall
- Total rainfall
- Amount of rainfall which has fallen in the logging interval

4 INTERNAL CONNECTIONS



Power supply:

To power the data logger with a solar panel, connect the panel to the +VPanel and GND terminals. To power the data logger with a direct voltage power supply unit, (for example HD32MT.SWD), connect the power supply unit to the +Vdc and GND terminals.

Attention: connect the PE terminal to ground through the cable gland at the bottom of the housing.

If a direct voltage power supply unit is used and the data logger is equipped with a rechargeable lead battery, short +Vdc and +Vpanel terminals to charge the battery (provided that +Vdc is within the range 18…27 Vdc).

Warning: the data logger is equipped with a battery protection function against excessive discharge, which disables the high-power consuming operations (mobile communication, digital buses, switched power for sensors, …) when the battery is too low, and restore such operations when the battery is recharged. **If the battery terminal (+BATT) is not connected, the battery protection must be disabled**, to avoid stopping the high-power consuming operations because of a too low voltage detection on +BATT terminal. The battery protection is disabled at the factory if the data logger is ordered without the optional battery. In the models with LCD, the battery protection can be enabled/disabled via the menu item *FUNC_MENU → LOW_BATT_PROT*.

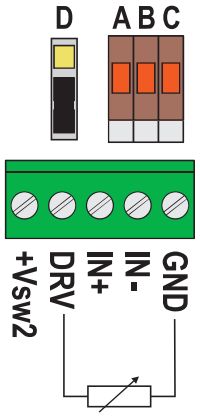
Analog inputs:

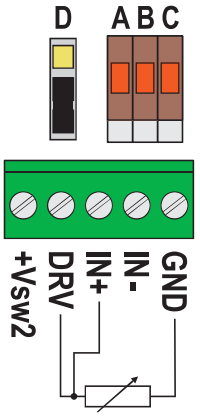
Each analog input can be configured as a Pt100/Pt1000, thermocouple, 0/4…20 mA (shunt resistance inside), 0…50 mV, -50…50 mV, 0…1 V, 0…10 V or potentiometric input. The current input accepts any value in the range 0 to 20 mA.

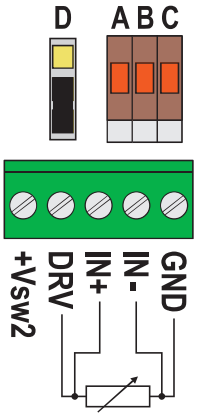
The switched power supply output **+Vsw2** can be used to power the sensors and can be configured as always active, active only during measurements acquisition or always disabled (if only passive sensors are used). When active, it has the same value as the battery voltage if the data logger is powered by a solar panel (+Vpanel input), while it is equal to the voltage of the +Vdc input if the data logger is powered by a direct voltage power supply unit (+Vdc input).

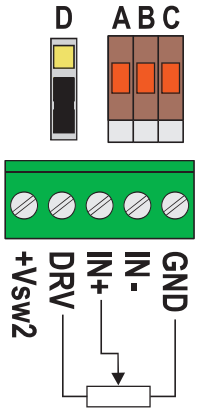
Configuration of inputs is done with the HD35AP-S software.

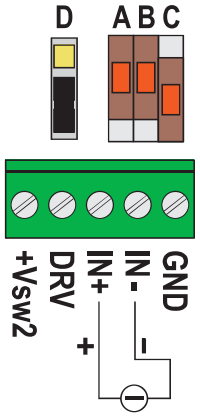
Below are the connections in the various configurations.

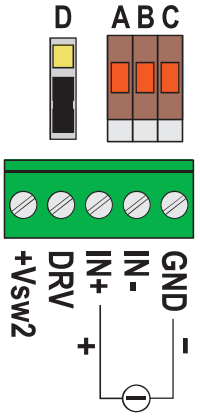
<table>
<tr>
<td> 

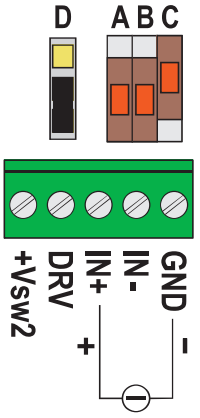
2-wire Pt100 / Pt1000</td>
<td> 

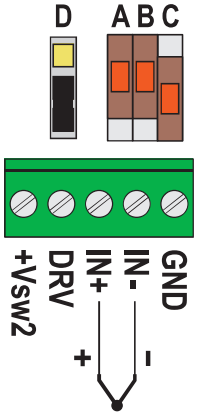
3-wire Pt100 / Pt1000</td>
<td> 

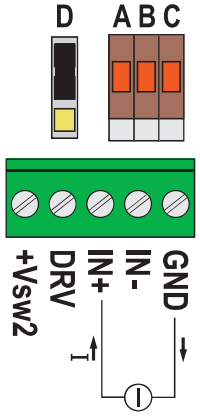
4-wire Pt100 / Pt1000</td>
<td> 

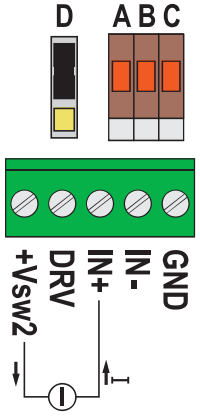
Potentiometer</td>
</tr>
<tr>
<td> 

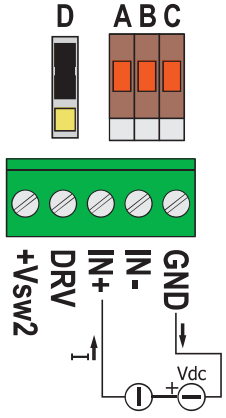
0…50 mV / -50…50 mV</td>
<td> 

0…1 V</td>
<td> 

0…10 V</td>
<td> 

Thermocouple
Pyrgeometer</td>
</tr>
<tr>
<td> 

0…20 mA / 4…20 mA
Transmitter with
active output</td>
<td> 

4…20 mA
Transmitter with
passive output
powered by +Vsw2</td>
<td> 

4…20 mA
Transmitter with
passive output
powered externally</td>
<td></td>
</tr>
</table>

SWIN1 contact input for rain gauge: connect the rain gauge output to the terminals SWIN1 and GND. The rain gauge must be connected to this input to have the calculated quantities (e.g. rainfall rate, …) available.

SWIN2 contact input: connect the output contact of the sensor between the terminals SWIN2 and GND. The default contact state can be configured: Normally Open (NO) or Normally Closed (NC). The open state is logged as 1, while the closed state is logged as 0. The logged contact state depends on how long the contact remains in the non-default state during the logging interval. If the contact remains in the non-default state for more than a given time (configurable and expressed as a percentage of the logging interval), the non-default state is logged. Vice versa, if the contact remains in the non-default state for less than the set time, the default state is logged.

Example 1: if the contact default state is Normally Open, the logging interval is 30 seconds and the time set for the contact state change is 50% of the logging interval, 0 is logged (contact closed, non-default state) if the contact remains closed for more than 15 seconds during the logging interval, otherwise 1 is logged (contact open, default state).

Example 2: if the contact default state is Normally Closed, the logging interval is 1 minute and the time set for the contact state change is 10% of the logging interval, 1 is logged (contact open, non-default state) if the contact remains open for more than 6 seconds during the logging interval, otherwise 0 is logged (contact closed, default state).

On request, the SWIN2 contact input can be factory set up for connecting a cup anemometer.

Serial port:

In "Master" mode, the port allows reading the measurements of the sensors with RS485 MODBUS-RTU output connected to the data logger serial port. In "Slave" mode, the data logger can communicate the measurements detected by the sensors connected to the other inputs to the "Master" unit of the MODBUS network.

Connect the signals **DATA+** and **DATA –** from the network of sensors to the terminals **TX+** and **TX-** respectively. Connect the ground of the network of sensors to the terminal GND.

Through an **optional** module connected to the serial port, the data logger can be connected to an ETHERNET network and communicate with MODBUS TCP/IP protocol.

The switched power supply output **+Vsw1** can be used to power the sensors and can be configured as always active, active only during measurements acquisition or always disabled. When active, it has the same value as the battery voltage if the data logger is powered by a solar panel (+Vpanel input), while it is equal to the voltage of the +Vdc input if the data logger is powered by a direct voltage power supply unit (+Vdc input).

SDI-12 port: there is only one port, the two SDI-12 inputs are in parallel to facilitate the connection of multiple sensors.

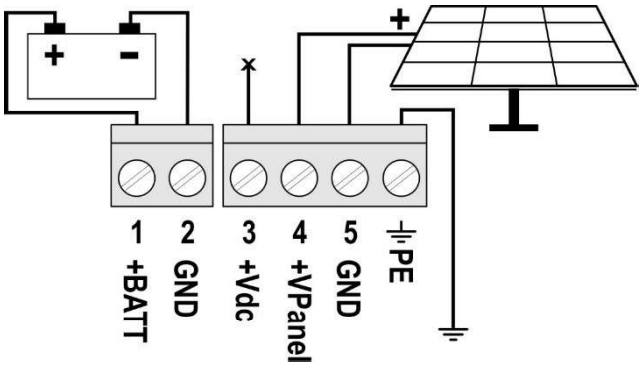
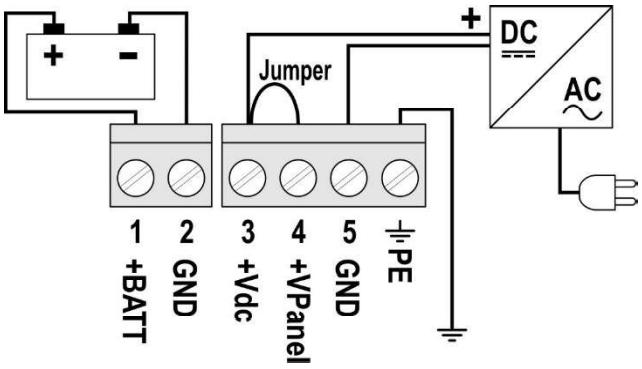
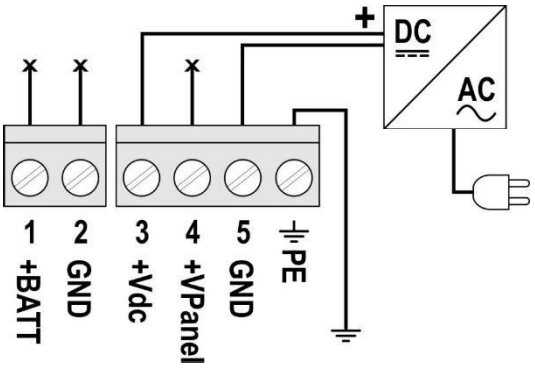
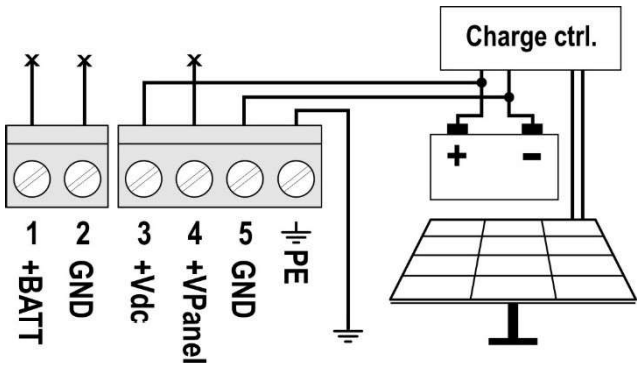
OUT1 / OUT2 alarm outputs: the instrument is equipped with 2 voltage-free contact alarm outputs that can be handled automatically by the data logger or manually. When handled automatically, the alarm conditions that activate the outputs can be configured by using the HD35AP-S software (see the instructions of the software). When handled manually, the alarm output states can be additionally configured via display and/or SMS commands.

WARNING:

Use the switched power supply output **+Vsw** only to power sensors having a maximum power supply greater or equal to:

- the battery voltage, if the data logger is powered by a solar panel (+Vpanel input);
- the +Vdc input voltage, if the data logger is powered by a direct voltage power supply unit (+Vdc input).

Summary of power supply options

Power supply option	Power supply input	Connection
SOLAR PANEL + 12 V BATTERY (internal or external)	12 V Solar Panel	
DC POWER UNIT + 12 V BATTERY (internal or external)	18…27 Vdc **To charge the battery, a jumper must be connected between +Vdc and +Vpanel**	
DC POWER UNIT (NO BATTERY)	7…30 Vdc (no ETHERNET) 12…30 Vdc (with ETHERNET)	
SOLAR PANEL + EXTERNAL BATTERY + EXTERNAL CHARGE CONTROLLER	Battery voltage (12 or 24 V)	

5 FRONT PANEL

1. Bicolor LED: red blinking indicates that the instrument is powered, blinks green to signal the mobile network activity.
2. **ESC** button: exits the selected function.
3. **FUNC/▼** button: in normal operation, it displays the maximum (MAX), the minimum (MIN) and the average (AVG) of the measurements; it scrolls downwards the available options or decreases the set value in the menu.
4. ▲ button: in normal operation, it scrolls the quantities measured by the data logger; it scrolls upwards the available options or decreases the set value in the menu.
5. **MENU/ENTER** button: allows access to the configuration menu; confirm the selected option or the set value in the menu.

Manual reset of the statistical values (MAX, MIN, AVG):

1) In measurement mode, press **FUNC** until the reset request appears.

   Note: the reset request appears only if the manual reset, not the daily automatic reset, is enabled.

2) Select *Yes* by using the ▲ button.

3) Press **ENTER**.

6 CONFIGURATION MENU

The menu allows displaying the data logger information and changing operation parameters. The menu is structured in levels, with main categories and submenus.

To access the menu you need to enter the **user password** (configurable through the appropriate menu item) or the **administrator password** (supplied with the system and not editable). Entering the user password makes some settings not changeable.

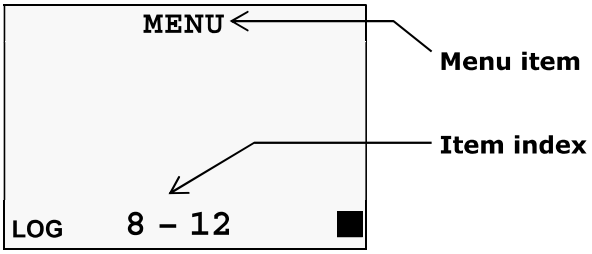
The instrument exits automatically the menu if no key is pressed for 3 minutes. After exiting the menu, the password remains active for a few minutes, during which you may enter the menu again without re-entering the password. It is possible to exit the menu by disabling immediately the password by performing a password level reset in the *Password* menu.

To access a menu parameter proceed as follows:

1. Press **MENU**, the first digit of the password will blink.

2. Using ▼/▲ keys, set the first digit and confirm with **ENTER**, the second digit of the password will blink. Set all the password digits in the same way.

3. Using ▼/▲ keys, select a main category in the menu and confirm with **ENTER**. Menu items appear one at a time in the upper part of the display; the lower part of the display shows the position of the item in the menu and the total number of items in the menu (for ex. "8 – 12" means the eighth item in a menu of 12 items).



4. If the selected main category has a submenu, select the desired item using ▼/▲ keys and confirm with **ENTER**. Scrolling the submenus displays also the parameter current setting.

5. To change the selected parameter, if allowed, use ▼/▲ keys to select the desired setting and confirm with **ENTER**. If you are setting a numeric value, you can fast forward by keeping ▼ or ▲ keys depressed.

To exit the main menu or a sub menu, select EXIT item (last menu item) or press ESC key.

If it is not allowed to change a parameter, the notice N/A (Not Available) will appear when pressing ENTER to select it.

Menu structure

The complete structure of the main menu with the relevant submenus is shown below.

1) DEV_INFO (information)

It lists the general information of the instrument: model, serial number, user code, group name, firmware version, calibration date, etc. Information is shown in the upper part of the display.

2) FUNC_MENU (statistics reset mode and test mode)

1) ***FUNC_RST_MODE***: statistical info (MAX, MIN, AVG) reset mode. Select *0* (*MAN_RST*) for the manual reset; select *1* (*AUTO_RST*) for the daily automatical reset at 6 am.
2) ***TEST_MODE***: enables or disables the test mode. Select *On* to activate the test mode. In test mode, the instrument temporarily suspends the logging activities and the calculation of the integral and statistical functions until the test mode is exited. The instrument automatically exits the test mode after 1 hour.

3) ***LOW_BATT_PROT***: enables or disables the battery protection against excessive discharge. Selecting *ON*, when the battery voltage falls below the configured threshold (see the following menu item *LOW_BATT_THLD_V*) the high-consumption activities of the data logger are disabled: mobile communication, communication with digital buses (RS485 and SDI-12), power supply of active sensors, relays. Instead, the instrument continues to measure and store passive sensor data. When the battery voltage returns above the threshold, all functions are automatically reactivated.
4) ***LOW_BATT_THLD_V***: battery protection threshold against excessive discharge (default = 10.90 V).
5) ***EXIT***: returns to the main menu.

3) RELY_MENU (relay settings)

1) ***RELY_ONE_MODE***: relay "one" functioning mode. Select *0* (*AUTO_MODE*) to enable the data logger automatic relay control as a function of the measurement alarm thresholds and other alarm conditions; select *1* (*MAN_MODE*) to control the relay status manually.
2) ***RELY_ONE_STAT***: Reset or set relay "one" status when relay "one" is handled manually. Select *Off/On* to respectively reset/set relay status.
3) ***RELY_TWO_MODE***: relay "two" functioning mode. Select *0* (*AUTO_MODE*) to enable the data logger automatic relay control as a function of the measurement alarm thresholds and other alarm conditions; select *1* (*MAN_MODE*) to control relay status manually.
4) ***RELY_TWO_STAT***: Reset or set relay "two" status when relay "two" is handled manually. Select *Off/On* to respectively reset/set relay status.
5) ***EXIT***: returns to the main menu.

4) GSM_MENU (mobile network settings)

1) ***SMS_ALARM***: enables or disables the alarm via SMS. Select *On* to enable the sending of alarm SMSes.
2) ***EML_ALARM***: enables or disables the alarm via e-mail. Select *On* to enable the sending of alarm e-mails.
3) ***EML_DATA_TX***: enables or disables the periodic sending of data via e-mail. Select *On* to enable the sending of data via e-mails.
4) ***EML_DATA_TX_TIME***: e-mail data sending interval.
   -1 (REAL TIME): immediately after logging
   0 (15 min): every 15 minutes
   1 (30 min): every 30 minutes
   2 (1 h): every hour
   3 (2 h): every 2 hours
   4 (4 h): every 4 hours
   5 (8 h): every 8 hours
   6 (12 h): every 12 hours
   7 (1 d): once a day
   8 (2 d): every 2 days
   9 (4 d): every 4 days
   10 (1 w): once a week
   11 (1 min): every minute
   12 (5 min): every 5 minutes
   13 (10 min): every 10 minutes

5) ***EML_DATA_TX_MODE***: format of the data sent via e-mail.
   0 (LOG): only internal LOG format (for database)
   1 (CSV): only standard CSV format (for Excel®)
   2 (LOG+CSV): both internal LOG and standard CSV formats
6) ***FTP_DATA_TX***: enables or disables the periodic sending of data via FTP. Select *On* to enable the sending of data via FTP.
7) ***FTP_DATA_TX_TIME***: FTP data sending interval.
   See the item *EML_DATA_TX_TIME* above for the available intervals.
8) ***FTP_DATA_TX_MODE***: format of the data sent via FTP.
   See the item *EML_DATA_TX_MODE* above for the available formats.
9) ***HTTP_DATA_TX***: enables or disables the periodic sending of data via HTTP. Select *On* to enable the sending of data via HTTP.
10) ***HTTP_DATA_TX_TIME***: HTTP data sending interval.
    See the item *EML_DATA_TX_TIME* above for the available intervals.
11) ***EXIT***: returns to the main menu.

5) THLD_MENU (alarm thresholds)

Note: the menu items depend on the data logger configuration.

1) ***CH1_Input Type_DOWN_THLD***: lower alarm threshold of the quantity measured by the analog input 1.
2) ***CH1_Input Type_UP_THLD***: higher alarm threshold of the quantity measured by the analog input 1.
3) ***CH2_Input Type_DOWN_THLD***: lower alarm threshold of the quantity measured by the analog input 2.
4) ***CH2_Input Type_UP_THLD***: higher alarm threshold of the quantity measured by the analog input 2.
5) ***CH3_Input Type_DOWN_THLD***: lower alarm threshold of the quantity measured by the analog input 3.
6) ***CH3_Input Type_UP_THLD***: higher alarm threshold of the quantity measured by the analog input 3.
7) ***CH4_Input Type_DOWN_THLD***: lower alarm threshold of the quantity measured by the analog input 4.
8) ***CH4_Input Type_UP_THLD***: higher alarm threshold of the quantity measured by the analog input 4.
9) ***ATM_PRES_DOWN_THLD_unit***: lower alarm threshold of the atmospheric pressure (optional) in the set unit of measurement.
10) ***ATM_PRES_UP_THLD_unit***: higher alarm threshold of the atmospheric pressure (optional) in the set unit of measurement.
11) ***BATT_DOWN_THLD_V***: lower alarm threshold of the battery voltage in V.
12) ***BATT_UP_THLD_V***: higher alarm threshold of the battery voltage in V.
13) ***VOLT_PWR_SPLY_DOWN_THLD_V***: lower alarm threshold of the external power supply in V.
14) ***VOLT_PWR_SPLY_UP_THLD_V***: higher alarm threshold of the external power supply in V.
15) ***MAX_RAIN_RATE_DOWN_THLD_unit***: lower alarm threshold of the rainfall rate in the set unit of measurement.
16) ***MAX_RAIN_RATE_UP_THLD_unit***: higher alarm threshold of the rainfall rate in the set unit of measurement.
17) ***CURR_RAIN_DOWN_THLD_unit***: lower alarm threshold of the rainfall quantity in the set unit of measurement.

18) ***CURR_RAIN_UP_THLD_unit***: higher alarm threshold of the rainfall quantity in the set unit of measurement.

19) ***THLD_ALRM***: enables or disables the buzzer when measurement thresholds are exceeded.

20) ***EXIT***: returns to the main menu.

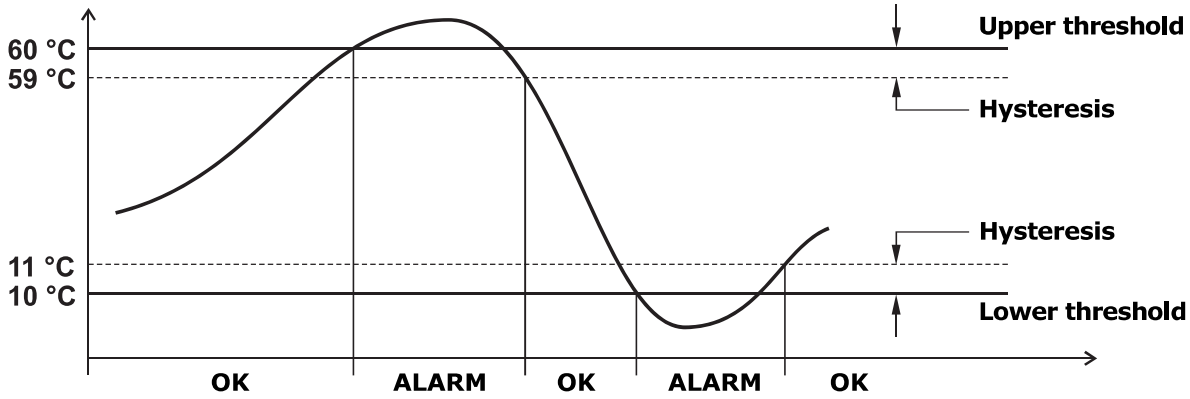
6) HYST_MENU (hysteresis of the alarm thresholds)

Note: the menu items depend on the data logger configuration.

1) ***CH1_Input Type_HYST%***: hysteresis of the alarm thresholds of the quantity measured by the analog input 1.
2) ***CH2_Input Type_HYST%***: hysteresis of the alarm thresholds of the quantity measured by the analog input 2.
3) ***CH3_Input Type_HYST%***: hysteresis of the alarm thresholds of the quantity measured by the analog input 3.
4) ***CH4_Input Type_HYST%***: hysteresis of the alarm thresholds of the quantity measured by the analog input 4.
5) ***ATM_PRES_HYST%***: hysteresis of the alarm thresholds of the atmospheric pressure (optional).
6) ***BATT_HYST%***: hysteresis of the alarm thresholds of the battery voltage.
7) ***VOLT_PWR_SPLY_HYST%***: hysteresis of the alarm thresholds of the external power supply.
8) ***MAX_RAIN_RATE_HYST%***: hysteresis of the alarm thresholds of the rainfall rate.
9) ***CURR_RAIN_HYST%***: hysteresis of the alarm thresholds of the rainfall quantity.
10) ***EXIT***: returns to the main menu.

The width of the hysteresis is a percentage (0 ... 100%) of the difference between the two alarm thresholds.

For example, if Hysteresis=2%, Lower threshold=10 °C and Upper threshold=60 °C, the hysteresis is (60-10)x2/100= 1 °C:



7) ALRM_DELY_MENU (delay, in seconds, for alarm activation)

Note: the menu items depend on the data logger configuration.

1) ***CH1_Input Type_ALRM_DELY***: delay for alarm activation of the quantity measured by the analog input 1.
2) ***CH2_Input Type_ALRM_DELY***: delay for alarm activation of the quantity measured by the analog input 2.
3) ***CH3_Input Type_ALRM_DELY***: delay for alarm activation of the quantity measured by the analog input 3.

4) ***CH4_Input Type_ALRM_DELY***: delay for alarm activation of the quantity measured by the analog input 4.
5) ***ATM_PRES_ALRM_DELY***: delay for alarm activation of the atmospheric pressure (optional).
6) ***BATT_ALRM_DELY***: delay for alarm activation of the battery voltage.
7) ***VOLT_PWR_SPLY_ALRM_DELY***: delay for alarm activation of the external power supply.
8) ***MAX_RAIN_RATE_ALRM_DELY***: delay for alarm activation of the rainfall rate.
9) ***CURR_RAIN_ALRM_DELY***: delay for alarm activation of the rainfall quantity.
10) ***EXIT***: returns to the main menu.

If the measured value drops below the lower threshold or exceeds the upper threshold, the alarm is generated after the time set. The alarm is generated immediately if 0 is set. If the alarm condition ends before the delay time is elapsed, the alarm is not generated.

8) MEAS_UNIT_MENU (measurement unit)

1) ***TEMP_UNIT_MEAS***: temperature unit of measurement.
   0 (°C)
   1 (°F)
2) ***PRES_UNIT_MEAS***: atmospheric pressure (optional) unit of measurement.
   0 (mbar)
   1 (bar)
   2 (Pa)
   3 (hPa)
   4 (kPa)
   5 (atm)
   6 (mmHg)
   7 (mmH_2O)
   8 (inHg)
   9 (inH_2O)
   10 (kgf/cm^2)
   11 (PSI)
3) ***WIND_SPEED_UNIT_MEAS***: wind speed unit of measurement.
   0 (m/s)
   1 (km/h)
   2 (ft/s)
   3 (mph)
   4 (knot)
4) ***RAIN_UNIT_MEAS***: rainfall quantity unit of measurement.
   0 (mm)
   1 (inches)
   2 (counts)
5) ***EXIT***: returns to the main menu.

9) LOG_MENU (logging)

1) ***LOG_STAT***: enables or disables the logging.
2) ***LOG_CYCL***: choice between cyclical management (the new data overwrite the old ones when the memory is full) or non-cyclical management (logging stops when the memory is full) of the data logger memory. Select *YES* for the cyclical management.
3) ***LOG_TIME***: choice of logging interval. If it is higher than the measuring interval, the average of the measurements acquired during the interval will be stored (except for the measurements for which the average is meaningless; e.g., the maximum rainfall rate, the total rainfall, etc.).
4) ***MEAS_TIME***: choice of the measurements acquisition interval. It is forced to the value *LOG_TIME* if a higher value is set.
5) ***LOG_DEL***: deletes all stored measurements from the data logger memory. Select *YES* to delete the memory.
6) ***EXIT***: returns to the main menu.

10) MOD_BUS _MENU (Modbus)

1) ***MOD_BUS_ADDR***: Modbus address.
2) ***MOD_BUS_BAUD_RATE_kbPS***: RS485 baud rate in kbps (9.6 / 19.2 / 38.4 / 57.6 / 115.2).
3) ***MOD_BUS_MODE***: RS485 communication mode (8N1 / 8N2 / 8E1 / 8E2 / 8O1 / 8O2).
4) ***WAIT_3_5_CHAR_AFTR_TX***: setting of the waiting time after transmission with Modbus protocol (*YES*=respect protocol and wait 3.5 characters after transmission / *nO*=violate protocol and go in receiving mode right after transmission).
5) ***MOD_BUS_SLV_PSW_STAT***: enabling of the password for changing the configuration via Modbus. Select *On* to enable the password.
6) ***MOD_BUS_MSTR_/SLV_CONF***: setting of the "Master" or "Slave" Modbus mode. Select *0* for "Master" mode or *1* for "Slave" mode.
7) ***EXIT***: returns to the main menu.

11) CLK_MENU (clock)

1) ***YEAR***: year.
2) ***MON***: month.
3) ***DAY***: day.
4) ***HOUR***: hour.
5) ***MIN***: minutes.
6) ***AUTO_TIME_SYNC***: enables or disables the automatic synchronization of the internal clock with a reference server. Select *On* to activate the automatic synchronization.
7) ***AUTO_TIME_ZONE***: enables or disables the automatic setting of the time zone. Select *On* to activate the automatic setting.
8) ***TIME_ZONE***: manual setting of the time zone.
9) ***EXIT***: returns to the main menu.

12) PSW_MENU (password)

1) ***RST_PSW_LVL***: exits the menu and deactivates immediately the password (the password will not remain active for some minutes as it normally happens when exiting the menu: you will need to re-enter the password even if you re-access immediately the menu).
2) ***SET_NEW_PSW***: sets user-level password.
3) ***EXIT***: returns to the main menu.

13) CAL_MENU (calibration) – *Only available with administrator password*

Note: the availability of the menu items depends on the data logger configuration.

1) ***RH_75%_CAL***: relative humidity sensor calibration at 75%RH.
2) ***RH_33%_CAL***: relative humidity sensor calibration at 33%RH.
3) ***RAIN_TIP_mm***: tipping bucket rain gauge resolution in mm.
4) ***RST_ALL_RAIN_CNTS***: reset of all the rainfall counters. Select *YES* to reset the counters.
5) ***CONT_INP_DFLT_STAT***: setting of the default state of the SWIN2 contact input as Normally Open (NO) or Normally Closed (NC).
6) ***dT%_CONT_INP_STAT_CHNG***: setting of the time required to accept the state change of the SWIN2 contact, expressed as a percentage of the logging interval.
7) ***CAL_TYPE***: choice between user calibration (*USER*) or factory calibration (*FACT*).
8) ***EXIT***: returns to the main menu.

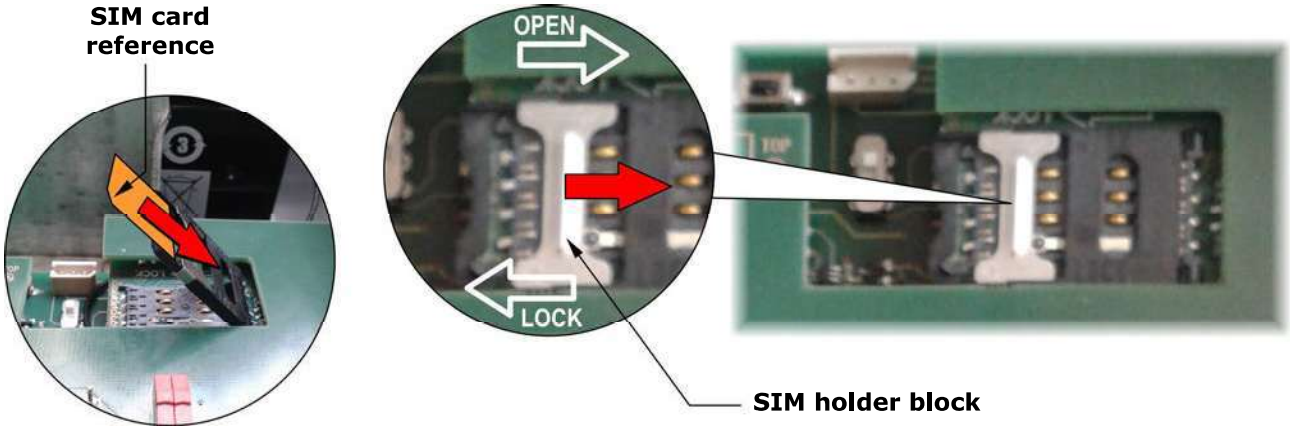
14) EXIT

Returns to measurement mode.

7 SIM CARD

In order to use the mobile network functionalities, a **SIM** card enabled for data transmission must be inserted into the data logger. The card should be requested to an operator that has an adequate coverage of the mobile network in the place where the data logger will be installed. To insert the card, proceed as follows.

1. Disconnect the power supply.
2. Open the housing.
3. Push the metal block of the SIM tray in the direction of the arrow OPEN, and rotate the tray upward.



4. Insert the SIM card into its tray so as the SIM card contacts face down and correspond to the contacts on the electronic board. The SIM has to be inserted between the metal block and the plastic part.
5. Put the SIM tray back in place and push the metal block in the direction of the arrow LOCK.
6. Close the housing.

Through the HD35AP-S software, set the necessary information for mobile network operation: SIM PIN, name of the APN access point, e-mail account and addresses, FTP address, telephone numbers, data transmission mode, etc. (see section "Mobile network settings" of the software online help).

Note: the switch located on the left of the SIM card must be set upwards. The downwards position and the PWRKEY button are used to update the firmware of the mobile communication module.

The connection symbol (CONN) on the display is ON when the instrument is connected to the mobile network (the symbol blinks while connecting).

Among the information that you can scroll on display with the button in the lower part of the data logger, there is also the strength RSSI (Received Signal Strength Indication) in dBm of the mobile network signal received.

8 USB CONNECTION

The data logger can be connected to a PC through the mini-USB connector located at the bottom of the housing. Remove the connector protective cap and connect the **CP23** cable.

USB connection doesn't require the installation of drivers: when the data logger is connected to a PC, Windows® operating system automatically recognizes the instrument as an HID device (Human Interface Device) and uses the drivers already included in the operating system.

The data logger must be powered separately, it is not powered by the PC USB port.

When the data logger is not connected to the PC, replace the mini-USB connector protective cap to ensure the watertight integrity of the instrument.

9 HD35AP-S SOFTWARE

The HD35AP-S software, downloadable free of charge from the Delta OHM website, allows:

- Configuring the data logger: measurements to be displayed, alarm thresholds and hystereses, logging and transmitting intervals, date and time, etc. (see chapters "HD35ED… data loggers configuration", "Alarms configuration", "GSM/3G/4G settings" and "Clock setting" of the software online help).
- Transferring stored data to PC (see chapters "Data download" and "Data download from FTP" of the software online help).
- Displaying measurements in real time, also in graphic format (see chapter "Monitor" of the software online help).
- Managing the graphical representation, print and export of acquired data (see chapter "Displaying data in the database" of the software online help).
- Calibrating the sensors (see chapter "Calibration" of the software online help).

For the connection of the data logger to the HD35AP-S software see chapter "Connection" of the software online help.

10 SMS COMMANDS

SMS messages containing commands can be sent by a mobile phone to the data logger. The SMS must be sent to the number of the SIM card inserted into the data logger. The following table lists the available commands:

Command	Description
RESET	Reset of the device
EMAIL-ON	Activates periodic download of measurement data via e-mail
EMAIL-OFF	Deactivates periodic download of measurement data via e-mail
EMAIL-PERIOD= *period index*	Set the transmission interval via e-mail, where *period index*: -1⇒Real time, 0⇒15 min, 1⇒30 min, 2⇒1 hour, 3⇒2 hours, 4⇒4 hours, 5⇒8 hours, 6⇒12 hours, 7⇒24 hours, 8⇒2 days, 9⇒4 days, 10⇒1 week 11⇒1 min, 12⇒5 min, 13⇒10 min
EMAIL-FORMAT= *format index*	Set the format of the data sent via e-mail, where *format index*: 1⇒log (format for database), 2⇒csv (format for Excel®), 3⇒log+csv
EMAIL-DL-START	Activates immediate data download via e-mail starting from the last measurement transmitted
EMAIL-DL-FROM=*YYYY/MM/DD HH:MM:SS*	Downloads data via e-mail starting from the specified date, where YYYY: year, MM: month, DD: day, HH: hour, MM: minutes, SS: seconds
EMAIL-DL-INTERVAL=*YYYY/MM/DD HH:MM:SS - YYYY/MM/DD HH:MM:SS*	Downloads via e-mail all data between the specified dates, where YYYY: year, MM: month, DD: day, HH: hour, MM: minutes, SS: seconds
EMAIL-ALARM-REPORT	Transmits via e-mail a report containing the measurements that can generate alarms
EMAIL-REPORT	Transmits via e-mail a report containing the current measurements
EMAIL-HELP	Transmits an e-mail containing a list of all SMS commands
FTP-ON	Activates the periodic download of measurement data via FTP
FTP-OFF	Deactivates the periodic download of measurement data via FTP
FTP-PERIOD= *period index*	Set the transmission interval via FTP, where *period index*: -1⇒Real time, 0⇒15 min, 1⇒30 min, 2⇒1 hour, 3⇒2 hours, 4⇒4 hours, 5⇒8 hours, 6⇒12 hours, 7⇒24 hours, 8⇒2 days, 9⇒4 days, 10⇒1 week 11⇒1 min, 12⇒5 min, 13⇒10 min
FTP-FORMAT= *format index*	Set the format of the data sent via FTP, where *format index*: 1⇒log (format for database), 2⇒csv (format for Excel®), 3⇒log+csv
FTP-DL-START	Activates immediate data download via FTP starting from the last measurement transmitted
FTP-DL-FROM=*YYYY/MM/DD HH:MM:SS*	Downloads data via FTP starting from the specified date, where YYYY: year, MM: month, DD: day, HH: hour, MM: minutes, SS: seconds
FTP-DL-INTERVAL=*YYYY/MM/DD HH:MM:SS - YYYY/MM/DD HH:MM:SS*	Downloads via FTP all data between the specified dates, where YYYY: year, MM: month, DD: day, HH: hour, MM: minutes, SS: seconds
FTP-ALARM-REPORT	Transmits via FTP a report containing the measurements that can generate alarms
FTP-REPORT	Transmits via FTP a report containing the current measurements
FTP-HELP	Transmits via FTP a file containing a list of all SMS commands
SMS-ALARM-ON	Activates the transmission of alarm SMS for the overrun of the measurement thresholds (if the device is selected for sending alarm SMS)
SMS-ALARM-OFF	Deactivates the transmission of alarm SMS for the overrun of the measurement thresholds for the selected devices
EMAIL-ALARM-ON	Activates the transmission of e-mail measurements alarms (if the device is selected for sending alarm e-mail)
EMAIL-ALARM-OFF	Deactivates the transmission of e-mail alarms for measurement alarms
SMS-ALARM-REPORT	Indicates whether the measurements are in alarm. Only the selected measurements are taken into consideration for SMS alarms

Command	Description
SMS-DEVICE-ALARM-REPORT	Transmits via SMS a report of the measurements selected for SMS alarms
SMS-DEVICE-REPORT	Transmits via SMS a report of the measurements of the device
SMS-HELP	Transmits an SMS containing the list of all SMS commands
TCP-SERVER-ON	Activates a TCP connection with AP acting as a TCP server
TCP-SERVER-OFF	Deactivates the TCP connection with the device acting as a TCP server
TCP-CLIENT-ON	Activates a TCP connection with the device acting as a TCP client
TCP-CLIENT-OFF	Deactivates the TCP connection with the device acting as a TCP client
TCP-SERVER-ADDRESS="*server address***"**	Specifies the server address for TCP connection when the device acts as TCP client. The server-address string can be a domain or a IP address
TCP-SERVER-PORT=*port number*	Specifies the number of the TCP port used by the remote server to accept connections with the device when the device acts as TCP client
TCP-LISTEN-PORT=*port number*	Specifies the number of the TCP listening port used by the device when the device acts as TCP server
HTTP-ON	Activates the periodic upload of measurement data on the HTTP server
HTTP-OFF	Deactivates the periodic upload of measurement data on the HTTP server
HTTP-PERIOD= *period index*	Sets the transmission interval via HTTP, where *period index*: -1⇒Real time, 0⇒15 min, 1⇒30 min, 2⇒1 hour, 3⇒2 hours, 4⇒4 hours, 5⇒8 hours, 6⇒12 hours, 7⇒24 hours, 8⇒2 days, 9⇒4 days, 10⇒1 week 11⇒1 min, 12⇒5 min, 13⇒10 min
HTTP-DL-START	Activates immediate data upload on the HTTP server starting from the last measurement transmitted
HTTP-DL-FROM=*YYYY/MM/DD HH:MM:SS*	Uploads data on the HTTP server starting from the specified date, where YYYY: year, MM: month, DD: day, HH: hour, MM: minutes, SS: seconds
HTTP-DL-INTERVAL=*YYYY/MM/DD HH:MM:SS - YYYY/MM/DD HH:MM:SS*	Uploads on the HTTP server all data between the specified dates, where YYYY: year, MM: month, DD: day, HH: hour, MM: minutes, SS: seconds
ADD-PHONE="*phone number***"**	Adds a phone number to the list of numbers considered for SMS alarms
CANC-PHONE	Delete my phone number and don't consider it any more for SMS alarms. The primary phone number cannot be deleted
ERASE-PHONE=*phone number index*	Deletes the phone number with specified index. This command is accepted only by the primary phone number
RELAY-1-AUTO	Sets relay 1 to be handled automatically
RELAY-1-MANUAL	Sets relay 1 to be handled manually
RELAY-1-RESET	Resets relay 1 status when the relay is handled manually
RELAY-1-SET	Sets relay 1 status when the relay is handled manually
RELAY-2-AUTO	Sets relay 2 to be handled automatically
RELAY-2-MANUAL	Sets relay 2 to be handled manually
RELAY-2-RESET	Resets relay 2 status when the relay is handled manually
RELAY-2-SET	Sets relay 2 status when the relay is handled manually
MEASURE-INTERVAL=*interval index*	Sets the measuring interval, where *interval index*: 0⇒1 s, 1⇒2 s, 2⇒5 s, 3⇒10 s, 4⇒15 s, 5⇒30 s, 6⇒1 min, 7⇒2 min, 8⇒5 min, 9⇒10 min, 10⇒15 min, 11⇒30 min, 12⇒1 hour
LOG-INTERVAL= *interval index*	Sets the logging interval, where *interval index*: 0⇒1 s, 1⇒2 s, 2⇒5 s, 3⇒10 s, 4⇒15 s, 5⇒30 s, 6⇒1 min, 7⇒2 min, 8⇒5 min, 9⇒10 min, 10⇒15 min, 11⇒30 min, 12⇒1 hour
COUNTERS-RESET	Resets all the rain counters

Up to 16 commands can be written in the same text message, separated by spaces or commas.

For safety, commands are executed only if they are coming from the cell numbers set in the HD35AP-S software and if the SMS text starts with a user-defined key word. The key word is

set through the HD35AP-S software, going to the menu " *GSM options* " at the item " *SMS recipients* " and setting the field " *SMS keyword* " (see chapter " *GSM settings* " of the software online help).

Example: supposing you entered the string "**>>>**" in the *SMS keyword* field and you wish to activate periodic download via e-mail of the measured data with an interval of 1 hour, you will have to send the following text message:

>>> EMAIL-ON EMAIL-PERIOD=2

With the commands EMAIL-HELP, FTP-HELP and SMS-HELP you can ask the base unit to send respectively by e-mail, to an FTP address and through SMS the complete list of the available SMS commands.

11 TCP/IP CONNECTION VIA MOBILE NETWORK

It is possible to interact with the data logger by establishing a direct TCP/IP connection via mobile network with a remote PC connected to the Internet.

The connection can be of two types:

1) **Data Logger = Client** , **PC = Server**

   The data logger acts as TCP client and requests the connection to the PC, the PC acts as TCP server and waits for the connection request. The server IP address (PC or Router) must be public and can be either static or dynamic; if the IP address is dynamic, it is convenient to register the server to a DDNS (Dynamic Domain Name System) service.

2) **Data Logger = Server** , **PC = Client**

   The PC acts as TCP client and requests the connection to the data logger, the data logger acts as TCP server and waits for the connection request. The server IP address (data logger) must be public and static.

Connection Data Logger = Client , PC = Server

1. Open a port (port forwarding) in the Modem/Router through which your PC connects to Internet (follow the instructions of your Modem/Router).
2. Connect the data logger to a PC USB port and perform the connection procedure with the HD35AP-S software.
3. In the HD35AP-S software select *Instruments setup >> GSM options >> GPRS TCP/IP client settings* and set the server IP address or domain name and port number (number of the port opened in the Modem/Router).
4. Disconnect the data logger from the USB port.
5. In the HD35AP-S software select *Tools >> Type of connection*, select the *TCP server* option and set the number of the port opened in the Modem/Router.
6. In the HD35AP-S software, select the *Connect* icon.
7. Send to the data logger the SMS command **TCP-CLIENT-ON**.

If the connection is not established within 30 minutes after sending the SMS command TCP-CLIENT-ON, the command must be sent again.

Alternatively, the server IP address or domain name and port number can be set in the data logger without connecting the data logger to the PC and without the HD35AP-S software by using the SMS commands **TCP-SERVER-ADDRESS** and **TCP-SERVER-PORT**.

Connection Data Logger = Server , PC = Client

1. Open a listening port in the data logger by using the SMS command **TCP-LISTEN-PORT** (for example, TCP-LISTEN-PORT=2020).
2. Send to the data logger the SMS command **TCP-SERVER-ON**.
3. The data logger replies with a first SMS to confirm that the command has been accepted. Wait for a second SMS with the confirmation that the *TCP server* functionality has been activated and with the IP address (and port number) assigned to the data logger.
4. In the HD35AP-S software select *Tools >> Type of connection*, select the *TCP client* option and set the IP address and port number of the datalogger.
5. In the HD35AP-S software, select the *Connect* icon.

If the connection is not established within 1 hour after sending the SMS command TCP-SERVER-ON, the command must be sent again.

12 MODBUS

The complete list of MODBUS registers for "Slave" mode is shown below. Depending on the system configuration, some of the listed registers could not be present if not significant for that particular system (for ex., atmospheric pressure measurement will not be available if it is not measured by the data logger). If you try to read a register that is not present, the instrument returns the fixed value 32767.

The following conventions have been used in the tables:

- Type: **b** = bit, **B** = 8 bits (Byte), **W** = 16 bits without sign (Word), **SW** = 16 bits with sign
- **(x10)** = decimal value expressed as an integer (e.g., if the content of the register is 184, the value is to be intended as 18,4).
- **(x100)** = centesimal value expressed as an integer (e.g., if the content of the register is 500, the value is to be intended as 5,00).

The commands for requesting units of measurement return an index according to the correspondence indicated in the table below:

TAB. 12.1: indexes of the units of measurement

Index	Unit of meas.	Index	Unit of meas.	Index	Unit of meas.	Index	Unit of meas.	Index	Unit of meas.
0	°C	14	inchH_2O	28	V	42	inch/h	56	µmol/(m^2s)
1	°F	15	kgf/cm^2	29	mV	43	counts/h	57	mm/day
2	%UR	16	PSI	30	mA	44	mW/m^2	58	kV
3	g/m^3	17	m/s	31	ppm	45	m	59	A
4	g/kg	18	km/h	32	Hz	46	s	60	kA
5	mbar	19	ft/s	33	%	47	µW/lumen	61	cm/s
6	bar	20	mph	34	degrees	48	dB	62	klux
7	Pa	21	knot	35	lux	49	dBA	63	m^3
8	hPa	22	W/m^2	36	m^2/s	50	kWh	64	g/(m^2s)
9	kPa	23	µW/cm^2	37	g (*)	51	l/s	65	µg/(m^3)
10	atm	24	Wh/m^2	38	mm	52	l/min	66	µm
11	mmHg	25	kWh/m^2	39	inch	53	gallon/min		
12	mmH_2O	26	J/m^2	40	counts	54	m^3/min		
13	inchHg	27	µJ/cm^2	41	mm/h	55	m^3/h	255	Undefined

(*) Gravity acceleration

TAB. 12.2: Coils – Read/Write parameters

Address	Type	Coil description
0	b	Waiting time after Modbus transmission: 0= immediate reception, 1=waiting time for 3.5 characters
1	b	Logging status: 0=active, 1=inactive
2	b	Logging mode: 0=non cyclic, 1=cyclic
3	b	Set 1 to delete the device logging memory. Bit zeroing is automatic.
4	b	Buzzer and relays activation in case of measurement alarm: 0=no, 1=yes
9	b	Protection of configuration with password: 0=no, 1=yes. Changing the parameter requires the Administrator password (see Holding Register 10036).
10	b	Height from the ground of the cup anemometer: 0=human height, 1=10 m
11	b	Average wind speed and direction calculation method (1) for the cup anemometer (3): 0=scalar, 1=vector
12	b	Wind direction measuring range (2) for the cup anemometer (3): 0=0…359.9°, 1=0…539.9°
13	b	Set 1 to reset all the "counter" type measurements (e.g. the rainfall quantity measurement). Bit zeroing is automatic.

Address	Type	Coil description
22	b	Wind speed when the measurement is below the minimum threshold of the sensors: 0=0 m/s, 1= threshold value in m/s

(1) **Scalar average**: the average intensity is calculated as average of intensities. For the calculation of the average direction, also called "prevailing direction", the velocity versor (unit vector having the same direction of the velocity vector) is considered for each measurement, and the versor coordinates along the measurement axes are calculated, then the average of the coordinates along each axis is calculated. The two average coordinates determine the average versor and therefore the average direction.

Vector average: for each measurement, the coordinates of the velocity vector along the measurement axes are calculated and then the average of the coordinates along each axis is calculated. The average intensity and the average direction are those determined by the two average coordinates.

(2) The wind direction measuring range, normally 0…359.9°, can be extended to 0…539.9° in order to avoid the oscillation of the measurement between initial and full scale if the direction continues to slightly fluctuate around 0° (the change 0⇒359.9° takes place, but not the change 359.9⇒0°). If 539.9° value is exceeded in extended mode, the output goes to 180°.

(3) If using HD51.3D… and HD52.3D… series ultrasonic anemometers, the type of average and the wind direction measuring range can be set directly in the anemometer.

TAB. 12.3: Input Registers – Read-only parameters

Address	Type	Input Register description
Measured values and status of measurement alarms		
0	SW	**TEMPERATURE** with **NTC10K** sensor in the set measurement unit (x10).
1	B	Alarm for temperature with NTC10K sensor of channel 1: 0=OFF, 1= lower threshold alarm, 2= higher threshold alarm
2	SW	**RELATIVE HUMIDITY** in % (x10).
3	B	Relative humidity alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
4	SW	**DEW POINT** in the set measurement unit (x10).
5	B	Dew Point alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
6	SW	**PARTIAL VAPOR PRESSURE** in hPa (x100).
7	B	Partial vapor pressure alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
8	SW	**MIXING RATIO** in g/Kg (x10).
9	B	Mixing ratio alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
10	SW	**ABSOLUTE HUMIDITY** in g/m^3 (x10).
11	B	Absolute humidity alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
12	SW	**WET BULB TEMPERATURE** in the set measurement unit (x10).
13	B	Wet bulb temperature alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
18	SW	**SOLAR RADIATION** in W/m^2.
19	B	Alarm for solar radiation: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
20	SW	**ILLUMINANCE** in lux (low range).
21	B	Illuminance (low range) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
24	SW	**ATMOSPHERIC PRESSURE** in the set measurement unit (the multiplier depends on the set unit).
25	B	Atmospheric pressure alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
30	SW	**DAILY SOLAR RADIATION** in Wh/m^2.
31	B	Alarm for daily solar radiation: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
32	SW	**CO_2** in ppm.

Address	Type	Input Register description
33	B	CO_2 alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
34	SW	**SOIL VOLUMETRIC WATER CONTENT** (**VWC**) in % (x10).
35	B	Soil volumetric water content alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
36	SW	**VWC PROBE OUTPUT** in mV (x10).
37	B	VWC probe output alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
52	SW	**WIND SPEED** (cup anemometer) in the set measurement unit (the multiplier depends on the set unit).
53	B	Wind speed (cup anemometer) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
54	SW	**WIND DIRECTION** (wind vane) in degrees.
55	B	Wind direction (wind vane) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
58	SW	**WIND CHILL** in the set measurement unit (x10).
59	B	Wind chill alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
64	SW	**TEMPERATURE** with **Pt100 sensor** (HD51.3D…/HD52.3D… anemometer) in the set measurement unit (x10).
65	B	Alarm for temperature with Pt100 sensor (HD51.3D…/HD52.3D… anemometer): 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
66	SW	**PYRANOMETER OUTPUT** in mV (x100).
67	B	Pyranometer output alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
68	SW	**UVA IRRADIANCE** in mW/m^2.
69	B	UVA irradiance alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
72	SW	**WET BULB TEMPERATURE** measured by the natural ventilation wet bulb probe, in the set measurement unit (x10).
73	B	Wet bulb temperature alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
74	SW	**GLOBE THERMOMETER TEMPERATURE** in the set measurement unit (x10).
75	B	Globe thermometer temperature alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
76	SW	**INDOOR WBGT INDEX** in the set measurement unit (x10).
77	B	Indoor WBGT index alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
78	SW	**OUTDOOR WBGT INDEX** in the set measurement unit (x10).
79	B	Outdoor WBGT index alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
80	SW	**ILLUMINANCE** in lux (high range).
81	B	Illuminance (high range) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
82	SW	**WIND GUST** in m/s for the cup anemometer.
83	B	Wind gust alarm for the cup anemometer: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
86	SW	**RAIN RATE** in counts/h.
87	B	Rain rate alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
88	SW	**DAILY RAIN** in counts.
89	B	Daily rain alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
92	SW	**WIND SPEED** (HD51.3D…/HD52.3D… anemometer) in m/s (x100).
93	B	Wind speed (HD51.3D…/HD52.3D… anemometer) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.

Address	Type	Input Register description
94	SW	**WIND DIRECTION** (HD51.3D…/HD52.3D… anemometer) in degrees (x10).
95	B	Wind direction (HD51.3D…/HD52.3D… anemometer) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
102	SW	**STATE OF THE CONTACT INPUT.**
103	B	Contact input alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
104	SW	**FLOW** in l/s.
105	B	Flow (l/s) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
106	SW	**FLOW** in l/min.
107	B	Flow (l/min) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
108	SW	**FLOW** in m^3/min.
109	B	Flow (m^3/min) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
110	SW	**SOIL VOLUMETRIC WATER CONTENT** (**VWC**) in % (x10) – channel **2**.
111	B	Soil volumetric water content alarm – channel 2: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
112	SW	**VWC PROBE OUTPUT** in mV (x10) – channel **2**.
113	B	VWC probe output alarm – channel 2: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
114	SW	**SOIL VOLUMETRIC WATER CONTENT** (**VWC**) in % (x10) – channel **3**.
115	B	Soil volumetric water content alarm – channel 3: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
116	SW	**VWC PROBE OUTPUT** in mV (x10) – channel **3**.
117	B	VWC probe output alarm – channel 3: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
118	SW	**AIR SPEED** (HD404…SR transmitter) in m/s (x100).
119	B	Air speed (HD404…SR transmitter) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
120	SW	**PAR** (Photosynthetically Active Radiation) in µmol/(m^2s).
121	B	PAR alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
122	SW	**RAINFALL QUANTITY IN THE LAST HOUR** in counts.
123	B	Alarm for rainfall quantity in the last hour: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
128	SW	**POWER SUPPLY VOLTAGE** in V (x100).
129	B	Power supply voltage alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
130	SW	**RAINFALL QUANTITY** in counts.
131	B	Rainfall quantity alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
132	SW	**SUN PRESENCE** (sunshine duration sensor): 0= sun absent, 1=sun present.
133	B	Sun presence alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
134	SW	**SUNSHINE DURATION** (sunshine duration sensor) in the last minute in seconds.
135	B	Alarm for sunshine duration in the last minute: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
136	SW	**SUNSHINE DURATION** (sunshine duration sensor) in the last 10 minutes in counts (number of tens of seconds).
137	B	Alarm for sunshine duration in the last 10 minutes: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
142	SW	**HOURLY EVAPOTRANSPIRATION** in mm/h (x100).
143	B	Hourly evapotranspiration alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
144	SW	**DAILY EVAPOTRANSPIRATION** in mm/h (x100).

Address	Type	Input Register description
145	B	Daily evapotranspiration alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
146	SW	**NET RADIATION** in W/m^2.
147	B	Net radiation alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
148	SW	**RELATIVE PRESSURE** in hPa.
149	B	Relative pressure alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
150	SW	**FLUID LEVEL** in m (x100).
151	B	Fluid level alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
152	SW	**LOWER LEAF WETNESS** in % (x10).
153	B	Lower leaf wetness alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
154	SW	**UPPER LEAF WETNESS** in % (x10).
155	B	Upper leaf wetness alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
156	SW	**PAR** (Photosynthetically Active Radiation) in µmol/(m^{2}s) (x10).
157	B	PAR (Photosynthetically Active Radiation, with decimal resolution) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
158	SW	**WIND GUST SPEED** (HD51.3D…/HD52.3D… anemometer) in m/s (x100).
159	B	Wind gust speed alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
160	SW	**WIND GUST DIRECTION** (HD51.3D…/HD52.3D… anemometer) in degrees (x10).
161	B	Wind gust direction alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
162	SW	**UVA IRRADIANCE** in W/m^2 (x100).
163	B	UVA irradiance (with centesimal resolution) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
168	SW	**RELATIVE HUMIDITY** in % (x100).
169	B	Relative humidity (with centesimal resolution) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
170	SW	**MAXIMUM RAIN RATE** in mm/h (x10).
171	B	Maximum rain rate alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
172	SW	**ALBEDO** in % (x10).
173	B	Albedo alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
Measured values and status of measurement alarms for configurable inputs		
1000 + 200 x (**N**-1)	SW	**TEMPERATURE** with 2-wire **Pt100 sensor** of channel **N** in the set measurement unit (x10).
1001 + 200 x (**N**-1)	B	Alarm for temperature with 2-wire Pt100 sensor of channel **N**: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1002 + 200 x (**N**-1)	SW	**TEMPERATURE** with 3-wire **Pt100 sensor** of channel **N** in the set measurement unit (x10).
1003 + 200 x (**N**-1)	B	Alarm for temperature with 3-wire Pt100 sensor of channel **N**: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1004 + 200 x (**N**-1)	SW	**TEMPERATURE** with 4-wire **Pt100 sensor** of channel **N** in the set measurement unit (x10).
1005 + 200 x (**N**-1)	B	Alarm for temperature with 4-wire Pt100 sensor of channel **N**: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1006 + 200 x (**N**-1)	SW	**TEMPERATURE** with 2-wire **Pt1000 sensor** of channel **N** in the set measurement unit (x10).
1007 + 200 x (**N**-1)	B	Alarm for temperature with 2-wire Pt1000 sensor of channel **N**: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.

Address	Type	Input Register description
1008 + 200x(**N**-1)	SW	**TEMPERATURE** with 3-wire **Pt1000 sensor** of channel **N** in the set measurement unit (x10).
1009 + 200x(**N**-1)	B	Alarm for temperature with 3-wire Pt1000 sensor of channel **N**: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1010 + 200x(**N**-1)	SW	**TEMPERATURE** with 4-wire **Pt1000 sensor** of channel **N** in the set measurement unit (x10).
1011 + 200x(**N**-1)	B	Alarm for temperature with 4-wire Pt1000 sensor of channel **N**: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1012 + 200x(**N**-1)	SW	**TEMPERATURE** with **TC_K** sensor of channel **N** in the set measurement unit (x10).
1013 + 200x(**N**-1)	B	Alarm for temperature with TC_K sensor of channel **N**: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1014 + 200x(**N**-1)	SW	**TEMPERATURE** with **TC_J** sensor of channel **N** in the set measurement unit (x10).
1015 + 200x(**N**-1)	B	Alarm for temperature with TC_J sensor of channel **N**: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1016 + 200x(**N**-1)	SW	**TEMPERATURE** WITH **TC_T** sensor of channel **N** in the set measurement unit (x10).
1017 + 200x(**N**-1)	B	Alarm for temperature with TC_T sensor of channel **N**: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1018 + 200x(**N**-1)	SW	**TEMPERATURE** with **TC_N** sensor of channel **N** in the set measurement unit (x10).
1019 + 200x(**N**-1)	B	Alarm for temperature with TC_N sensor of channel **N**: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1026 + 200x(**N**-1)	SW	**TEMPERATURE** with **TC_E** sensor of channel **N** in the set measurement unit (x10).
1027 + 200x(**N**-1)	B	Alarm for temperature with TC_E sensor of channel **N**: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1028 + 200x(**N**-1)	SW	Input value in **mV** of channel **N** (x10). Only if channel **N** is configured as **0...1 V** input.
1029 + 200x(**N**-1)	B	Alarm for channel **N** if the channel is configured as 0…1 V input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1030 + 200x(**N**-1)	SW	Input value in **mV** of channel **N** (x100). Only if channel **N** is configured as **0...50 mV** input.
1031 + 200x(**N**-1)	B	Alarm for channel **N** if the channel is configured as 0…50 mV input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1032 + 200x(**N**-1)	SW	Input value in **mA** of channel **N** (x100). Only if channel **N** is configured as 4…20 mA input.
1033 + 200x(**N**-1)	B	Alarm for channel **N** if the channel is configured as 4…20 mA input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1034 + 200x(**N**-1)	SW	Position of **potentiometer** in % of channel **N**. Only if channel **N** is configured as potentiometric input.
1035 + 200x(**N**-1)	B	Alarm for channel **N** if the channel is configured as potentiometric input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1036 + 200x(**N**-1)	SW	Value of quantity associated to channel **N** if the channel is configured as 0…1 V input.
1037 + 200x(**N**-1)	B	Alarm for quantity associated to channel **N** if the channel is configured as 0…1 V input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1038 + 200x(**N**-1)	SW	Value of quantity associated to channel **N** if the channel is configured as 0…50 mV input.
1039 + 200x(**N**-1)	B	Alarm for quantity associated to channel **N** if the channel is configured as 0…50 mV input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1040 + 200x(**N**-1)	SW	Value of quantity associated to channel **N** if the channel is configured as 4…20 mA input.
1041 + 200x(**N**-1)	B	Alarm for quantity associated to channel **N** if the channel is configured as 4…20 mA input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.

Address	Type	Input Register description
1042 + 200x(**N**-1)	SW	Value of quantity associated to channel **N** if the channel is configured as potentiometric input.
1043 + 200x(**N**-1)	B	Alarm for quantity associated to channel **N** if the channel is configured as potentiometric input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1044 + 200x(**N**-1)	SW	Input value in **mV** of channel **N**. Only if channel **N** is configured as **0...10 V** input.
1045 + 200x(**N**-1)	B	Alarm for channel **N** if the channel is configured as 0…10 V input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1046 + 200x(**N**-1)	SW	Value of quantity associated to channel **N** if the channel is configured as 0…10 V input.
1047 + 200x(**N**-1)	B	Alarm for quantity associated to channel **N** if the channel is configured as 0…10 V input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1048 + 200x(**N**-1)	SW	Value of the **Nth** quantity acquired from digital bus.
1049 + 200x(**N**-1)	B	Alarm for Nth quantity acquired from digital bus: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1050 + 200x(**N**-1)	SW	Input value in **mV** of channel **N** (x100). Only if channel **N** is configured as **-50...50 mV** input.
1051 + 200x(**N**-1)	B	Alarm for channel **N** if the channel is configured as -50…50 mV input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1052 + 200x(**N**-1)	SW	Value of quantity associated to channel **N** if the channel is configured as -50…50 mV input.
1053 + 200x(**N**-1)	B	Alarm for quantity associated to channel **N** if the channel is configured as -50…50 mV input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
1054 + 200x(**N**-1)	SW	**FIR** (Far Infrared) **RADIATION** in **W/m²** of channel **N**. Only if channel **N** is configured as **Pyrgeometer** input.
1055 + 200x(**N**-1)	B	Alarm for channel **N** if the channel is configured as pyrgeometer input: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
Rainfall counters		
4006 & 4007	SW	**RAINFALL QUANTITY** (HD52.3DT…) in the set measurement unit. Register 4007 contains the most significant bits.
4008	B	Rainfall quantity (HD52.3DT…) alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
4009 & 4010	SW	**DAILY RAINFALL QUANTITY** in the set measurement unit. Register 4010 contains the most significant bits.
4011	B	Daily rainfall quantity alarm: 0=OFF, 1=lower threshold alarm, 2=higher threshold alarm.
da 4128 a 4130	SW	**TOTAL RAINFALL QUANTITY** (analog tipping bucket rain gauge) in mm (x1000). Register 4130 contains the most significant bits.
Measurement units and resolution		
5000	W	Unit of measurement for **TEMPERATURE** with **NTC10K** sensor: 0=°C, 1=°F.
5004	W	**DEW POINT** measurement unit: 0=°C, 1=°F.
5012	W	**WET BULB TEMPERATURE** measurement unit: 0=°C, 1=°F.
5021	SW	**ILLUMINANCE** resolution: -2=100, -1=10, 0=1
5024	W	**ATMOSPHERIC PRESSURE** measurement unit: see TAB 12.1
5025	SW	**ATMOSPHERIC PRESSURE** resolution: …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …
5052	W	**WIND SPEED** measurement unit: see TAB 12.1
5053	SW	**WIND SPEED** resolution: …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …
5058	W	**WIND CHILL** measurement unit: 0=°C, 1=°F.
5064	W	Unit of measurement for **TEMPERATURE** with **Pt100** sensor (HD51.3D…/HD52.3D… anemometer): 0=°C, 1=°F.
5072	W	Unit of measurement for **WET BULB TEMPERATURE** measured by the natural ventilation wet bulb probe: 0=°C, 1=°F.

Address	Type	Input Register description
5074	W	Unit of measurement for **GLOBE THERMOMETER TEMPERATURE**: 0=°C, 1=°F.
5076	W	Unit of measurement for **INDOOR WBGT INDEX**: 0=°C, 1=°F.
5078	W	Unit of measurement for **OUTDOOR WBGT INDEX**: 0=°C, 1=°F.
6000 + 200x(**N**-1)	W	Unit of measurement for **TEMPERATURE** with **2-wire Pt100** sensor of channel **N**: 0=°C, 1=°F.
6002 + 200x(**N**-1)	W	Unit of measurement for **TEMPERATURE** with **3-wire Pt100** sensor of channel **N**: 0=°C, 1=°F.
6004 + 200x(**N**-1)	W	Unit of measurement for **TEMPERATURE** with **4-wire Pt100** sensor of channel **N**: 0=°C, 1=°F.
6006 + 200x(**N**-1)	W	Unit of measurement for **TEMPERATURE** with **2-wire Pt1000** sensor of channel **N**: 0=°C, 1=°F.
6008 + 200x(**N**-1)	W	Unit of measurement for **TEMPERATURE** with **3-wire Pt1000** sensor of channel **N**: 0=°C, 1=°F.
6010 + 200x(**N**-1)	W	Unit of measurement for **TEMPERATURE** with **4-wire Pt1000** sensor of channel **N**: 0=°C, 1=°F.
6012 + 200x(**N**-1)	W	Unit of measurement for **TEMPERATURE** with **TC_K** sensor of channel **N**: 0=°C, 1=°F.
6014 + 200x(**N**-1)	W	Unit of measurement for **TEMPERATURE** with **TC_J** sensor of channel **N**: 0=°C, 1=°F.
6016 + 200x(**N**-1)	W	Unit of measurement for **TEMPERATURE** with **TC_T** sensor of channel **N**: 0=°C, 1=°F.
6018 + 200x(**N**-1)	W	Unit of measurement for **TEMPERATURE** with **TC_N** sensor of channel **N**: 0=°C, 1=°F.
6026 + 200x(**N**-1)	W	Unit of measurement for **TEMPERATURE** with **TC_E** sensor of channel **N**: 0=°C, 1=°F.
6036 + 200x(**N**-1)	W	Measurement unit of the quantity associated to channel **N** if the channel is configured as 0…1 V input. See TAB 12.1
6037 + 200x(**N**-1)	SW	Resolution of the quantity associated to channel **N** if the channel is configured as 0…1 V input: …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …
6038 + 200x(**N**-1)	W	Measurement unit of the quantity associated to channel **N** if the channel is configured as 0…50 mV. See TAB 12.1
6039 + 200x(**N**-1)	SW	Resolution of the quantity associated to channel **N** if the channel is configured as 0…50 mV: …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …
6040 + 200x(**N**-1)	W	Measurement unit of the quantity associated to channel **N** if the channel is configured as 4…20 mA input. See TAB 12.1
6041 + 200x(**N**-1)	SW	Resolution of the quantity associated to channel **N** if the channel is configured as 4…20 mA input: …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …
6042 + 200x(**N**-1)	W	Measurement unit of the quantity associated to channel **N** if the channel is configured as potentiometric input. See TAB 12.1
6043 + 200x(**N**-1)	SW	Resolution of the quantity associated to channel **N** if the channel is configured as potentiometric input: …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …
6046 + 200x(**N**-1)	W	Measurement unit of the quantity associated to channel **N** if the channel is configured as 0…10 V input. See TAB 12.1
6047 + 200x(**N**-1)	SW	Resolution of the quantity associated to channel **N** if the channel is configured as 0…10 V input: …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …
6048 + 200x(**N**-1)	W	Measurement unit of the **Nth** quantity acquired from digital bus. See TAB 12.1
6049 + 200x(**N**-1)	SW	Resolution of the Nth quantity acquired from digital bus: …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …
6052 + 200x(**N**-1)	W	Measurement unit of the quantity associated to channel **N** if the channel is configured as -50…50 mV. See TAB 12.1
6053 + 200x(**N**-1)	SW	Resolution of the quantity associated to channel **N** if the channel is configured as -50…50 mV: …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …
9002	W	Measurement unit of the quantity associated to the channel if the channel is configured as counter. See TAB 12.1
9003	SW	Resolution of the quantity associated to the channel if the channel is configured as counter: …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …

Address	Type	Input Register description
9004	W	Measurement unit of the **RAINFALL QUANTITY** (HD52.3DT…). See TAB 12.1
9005	SW	Resolution of the **RAINFALL QUANTITY** (HD52.3DT…): …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …
9006	W	Measurement unit of the **DAILY RAINFALL QUANTITY.** See TAB 12.1
9007	SW	Resolution of the **DAILY RAINFALL QUANTITY**: …, -2=100, -1=10, 0=1, 1=0.1, 2=0.01, …
General information		
10000	W	Year of last measurement.
10001	W	Month of last measurement.
10002	W	Day of last measurement.
10003	W	Hour of last measurement.
10004	W	Minutes of last measurement.
10005	W	Seconds of last measurement.
10008	SW	RF signal level in dBm.
10009	W	Battery level: 0=empty, 1=half full , 2=full, 3=external power supply
10010	W	Time, in seconds, elapsed since the last measurement.
10011	W	RF signal level expressed as 0 to 7 scale.
10013	W	Password level for the current connection: 0=no password, 1=user level, 2= administrator level

TAB. 12.4: Holding Registers – Read/Write parameters

Address	Type	Holding Register description
Measurement alarm thresholds		
0	SW	Lower alarm threshold for **TEMPERATURE** with **NTC10K** sensor in the set measurement unit (x10).
1	SW	Higher alarm threshold for temperature with NTC10K sensor in the set measurement unit (x10).
2	SW	**RH** lower alarm threshold in % (x10).
3	SW	RH higher alarm threshold in % (x10).
4	SW	**DEW POINT** lower alarm threshold in the set measurement unit (x10).
5	SW	Dew point higher alarm threshold in the set measurement unit (x10).
6	SW	**PARTIAL VAPOR PRESSURE** lower alarm threshold in hPa (x100).
7	SW	Partial vapor pressure higher alarm threshold in hPa (x100).
8	SW	**MIXING RATIO** lower alarm threshold in g/Kg (x10).
9	SW	Mixing ratio higher alarm threshold in g/Kg (x10).
10	SW	**ABSOLUTE HUMIDITY** lower alarm threshold in g/m^3 (x10).
11	SW	Absolute humidity higher alarm threshold in g/m^3 (x10).
12	SW	**WET BULB TEMPERATURE** lower alarm threshold in the set measurement unit (x10).
13	SW	Wet bulb temperature higher alarm threshold in the set measurement unit (x10).
18	SW	Lower alarm threshold for **SOLAR RADIATION** in W/m^2.
19	SW	Higher alarm threshold for solar radiation in W/m^2.
20	SW	**ILLUMINANCE** (low range) lower alarm threshold in lux.
21	SW	Illuminance (low range) higher alarm threshold in lux
24	SW	**ATMOSPHERIC PRESSURE** lower alarm threshold in the set measurement unit (the multiplier depends on the set unit).
25	SW	Atmospheric pressure higher alarm threshold in the set measurement unit (the multiplier depends on the set unit).
30	SW	Lower alarm threshold for **DAILY SOLAR RADIATION** in Wh/m^2.
31	SW	Higher alarm threshold for daily solar radiation in Wh/m^2.
32	SW	**CO_2** lower alarm threshold in ppm.
33	SW	CO_2 higher alarm threshold in ppm.

Address	Type	Holding Register description
34	SW	Lower alarm threshold for **SOIL VOLUMETRIC WATER CONTENT** (**VWC**) in % (x10).
35	SW	Higher alarm threshold for soil volumetric water content (VWC) in % (x10).
36	SW	Lower alarm threshold for **VWC PROBE OUTPUT** in mV (x10).
37	SW	Higher alarm threshold for VWC probe output in mV (x10).
52	SW	**WIND SPEED** (cup anemometer) lower alarm threshold in the set measurement unit (the multiplier depends on the set unit).
53	SW	Wind speed (cup anemometer) higher alarm threshold in the set measurement unit (multiplier depends on the set unit).
54	SW	**WIND DIRECTION** (wind vane) lower alarm threshold in degrees.
55	SW	Wind direction (wind vane) higher alarm threshold in degrees.
58	SW	Lower alarm threshold for **WIND CHILL** in the set measurement unit (x10).
59	SW	Higher alarm threshold for wind chill in the set measurement unit (x10).
64	SW	Lower alarm threshold for **TEMPERATURE** with **Pt100** sensor (HD51.3D…/HD52.3D… anemometer) in the set measurement unit (x10).
65	SW	Higher alarm threshold for temperature with Pt100 sensor (HD51.3D…/HD52.3D… anemometer) in the set measurement unit (x10).
66	SW	Lower alarm threshold for **PYRANOMETER OUTPUT** in mV (x100).
67	SW	Higher alarm threshold for **PYRANOMETER OUTPUT** in mV (x100).
68	SW	**UVA IRRADIANCE** lower alarm threshold in mW/m^2.
69	SW	UVA irradiance higher alarm threshold in mW/m^2.
72	SW	Lower alarm threshold for **WET BULB TEMPERATURE** measured by the natural ventilation wet bulb probe, in the set measurement unit (x10).
73	SW	Higher alarm threshold for wet bulb temperature measured by the natural ventilation wet bulb probe, in the set measurement unit (x10).
74	SW	Lower alarm threshold for **GLOBE THERMOMETER TEMPERATURE** in the set measurement unit (x10).
75	SW	Higher alarm threshold for globe thermometer temperature in the set measurement unit (x10).
76	SW	**INDOOR WBGT INDEX** lower alarm threshold in the set measurement unit (x10).
77	SW	Indoor WBGT index higher alarm threshold in the set measurement unit (x10).
78	SW	**OUTDOOR WBGT INDEX** lower alarm threshold in the set measurement unit (x10).
79	SW	Outdoor WBGT index higher alarm threshold in the set measurement unit (x10).
80	SW	**ILLUMINANCE** (high range) lower alarm threshold in lux.
81	SW	Illuminance (high range) higher alarm threshold in lux
82	SW	**WIND GUST** lower alarm threshold in m/s for the cup anemometer.
83	SW	Wind gust higher alarm threshold in m/s for the cup anemometer.
86	SW	**RAIN RATE** lower alarm threshold in counts/h.
87	SW	Rain rate higher alarm threshold in counts/h.
88	SW	**DAILY RAIN** lower alarm threshold in counts.
89	SW	Daily rain higher alarm threshold in counts.
92	SW	**WIND SPEED** (HD51.3D…/HD52.3D… anemometer) lower alarm threshold in m/s (x100).
93	SW	Wind speed (HD51.3D…/HD52.3D… anemometer) higher alarm threshold in m/s (x100).
94	SW	**WIND DIRECTION** (HD51.3D…/HD52.3D… anemometer) lower alarm threshold in degrees (x10).
95	SW	Wind direction (HD51.3D…/HD52.3D… anemometer) higher alarm threshold in degrees (x10).
104	SW	**FLOW** lower alarm threshold in l/s.
105	SW	Flow higher alarm threshold in l/s.
106	SW	**FLOW** lower alarm threshold in l/min.
107	SW	Flow higher alarm threshold in l/min.
108	SW	**FLOW** lower alarm threshold in m^3/min.
109	SW	Flow higher alarm threshold in m^3/min.
110	SW	Lower alarm threshold for **SOIL VOLUMETRIC WATER CONTENT** (**VWC**) in % (x10) – channel **2**.

Address	Type	Holding Register description
111	SW	Higher alarm threshold for soil volumetric water content in % (x10) – channel 2.
112	SW	Lower alarm threshold for **VWC PROBE OUTPUT** in mV (x10) – channel **2**.
113	SW	Higher alarm threshold for VWC probe output in mV (x10) – channel 2.
114	SW	Lower alarm threshold for **SOIL VOLUMETRIC WATER CONTENT** (**VWC**) in % (x10) – channel **3**.
115	SW	Higher alarm threshold for soil volumetric water content in % (x10) – channel 3.
116	SW	Lower alarm threshold for **VWC PROBE OUTPUT** in mV (x10) – channel **3**.
117	SW	Higher alarm threshold for VWC probe output in mV (x10) – channel 3.
118	SW	**AIR SPEED** (HD404…SR transmitter) lower alarm threshold in m/s (x100).
119	SW	Air speed (HD404…SR transmitter) higher alarm threshold in m/s (x100).
120	SW	**PAR** (Photosynthetically Active Radiation) lower alarm threshold in µmol/(m^2s).
121	SW	PAR higher alarm threshold in µmol/(m^2s).
122	SW	Lower alarm threshold for **RAINFALL QUANTITY IN THE LAST HOUR** in counts.
123	SW	Higher alarm threshold for rainfall quantity in the last hour in counts.
128	SW	**POWER SUPPLY VOLTAGE** lower alarm threshold in V (x100).
129	SW	Power supply voltage higher alarm threshold in V (x100).
130	SW	**RAINFALL QUANTITY** lower alarm threshold in counts.
131	SW	Rainfall quantity higher alarm threshold in counts.
132	SW	**SUN PRESENCE** (sunshine duration sensor) lower alarm threshold.
133	SW	Sun presence (sunshine duration sensor) higher alarm threshold.
134	SW	Lower alarm threshold for **SUNSHINE DURATION** (sunshine duration sensor) in the last minute in seconds.
135	SW	Higher alarm threshold for sunshine duration (sunshine duration sensor) in the last minute in seconds.
136	SW	Lower alarm threshold for **SUNSHINE DURATION** (sunshine duration sensor) in the last 10 minutes in counts (number of tens of seconds).
137	SW	Higher alarm threshold for sunshine duration (sunshine duration sensor) in the last 10 minutes in counts (number of tens of seconds).
142	SW	**HOURLY EVAPOTRANSPIRATION** lower alarm threshold in mm/h (x100).
143	SW	Hourly evapotranspiration higher alarm threshold in mm/h (x100).
144	SW	**DAILY EVAPOTRANSPIRATION** lower alarm threshold in mm/h (x100).
145	SW	Daily evapotranspiration higher alarm threshold in mm/h (x100).
146	SW	**NET RADIATION** lower alarm threshold in W/m^2.
147	SW	Net radiation higher alarm threshold in W/m^2.
148	SW	**RELATIVE PRESSURE** lower alarm threshold in hPa.
149	SW	Relative pressure higher alarm threshold in hPa.
150	SW	**FLUID LEVEL** lower alarm threshold in m (x100).
151	SW	Fluid level higher alarm threshold in m (x100).
152	SW	**LOWER LEAF WETNESS** lower alarm threshold in % (x10).
153	SW	Lower leaf wetness higher alarm threshold in % (x10).
154	SW	**UPPER LEAF WETNESS** lower alarm threshold in % (x10).
155	SW	Upper leaf wetness higher alarm threshold in % (x10).
156	SW	**PAR** (Photosynthetically Active Radiation) lower alarm threshold in µmol/(m^2s) (x10).
157	SW	PAR (Photosynthetically Active Radiation) higher alarm threshold in µmol/(m^2s) (x10).
158	SW	**WIND GUST SPEED** (HD51.3D…/HD52.3D… anemometer) lower alarm threshold in m/s (x100).
159	SW	Wind gust speed (HD51.3D…/HD52.3D… anemometer) higher alarm threshold in m/s (x100).
160	SW	**WIND GUST DIRECTION** (HD51.3D…/HD52.3D… anemometer) lower alarm threshold in degrees (x10).
161	SW	Wind gust direction (HD51.3D…/HD52.3D… anemometer) higher alarm threshold in degrees (x10).
162	SW	**UVA IRRADIANCE** lower alarm threshold in W/m^2 (x100).

Address	Type	Holding Register description
163	SW	UVA irradiance higher alarm threshold in W/m^2 (x100).
168	SW	**RELATIVE HUMIDITY** lower alarm threshold in % (x100).
169	SW	Relative Humidity higher alarm threshold in % (x100).
170	SW	**MAXIMUM RAIN RATE** lower alarm threshold in mm/h (x10).
171	SW	Maximum rain rate higher alarm threshold in mm/h (x10).
172	SW	**ALBEDO** lower alarm threshold in % (x10).
173	SW	Albedo higher alarm threshold in % (x10).
Measurement alarm thresholds for configurable inputs		
1000 + 200 x (**N**-1)	SW	Lower alarm threshold for **TEMPERATURE** with **2-wire Pt100** sensor of channel **N** in the set measurement unit (x10).
1001 + 200 x (**N**-1)	SW	Higher alarm threshold for temperature with 2-wire Pt100 sensor of channel **N** in the set measurement unit (x10).
1002 + 200 x (**N**-1)	SW	Lower alarm threshold for **TEMPERATURE** with **3-wire Pt100** sensor of channel **N** in the set measurement unit (x10).
1003 + 200 x (**N**-1)	SW	Higher alarm threshold for temperature with 3-wire Pt100 sensor of channel **N** in the set measurement unit (x10).
1004 + 200 x (**N**-1)	SW	Lower alarm threshold for **TEMPERATURE** with **4-wire Pt100** sensor of channel **N** in the set measurement unit (x10).
1005 + 200 x (**N**-1)	SW	Higher alarm threshold for temperature with 4-wire Pt100 sensor of channel **N** in the set measurement unit (x10).
1006 + 200 x (**N**-1)	SW	Lower alarm threshold for **TEMPERATURE** with **2-wire Pt1000** sensor of channel **N** in the set measurement unit (x10).
1007 + 200 x (**N**-1)	SW	Higher alarm threshold for temperature with 2-wire Pt1000 sensor of channel **N** in the set measurement unit (x10).
1008 + 200 x (**N**-1)	SW	Lower alarm threshold for **TEMPERATURE** with **3-wire Pt1000** sensor of channel **N** in the set measurement unit (x10).
1009 + 200 x (**N**-1)	SW	Higher alarm threshold for temperature with 3-wire Pt1000 sensor of channel **N** in the set measurement unit (x10).
1010 + 200 x (**N**-1)	SW	Lower alarm threshold for **TEMPERATURE** with **4-wire Pt1000** sensor of channel **N** in the set measurement unit (x10).
1011 + 200 x (**N**-1)	SW	Higher alarm threshold for temperature with 4-wire Pt1000 sensor of channel **N** in the set measurement unit (x10).
1012 + 200 x (**N**-1)	SW	Lower alarm threshold for **TEMPERATURE** with **TC_K** sensor of channel **N** in the set measurement unit (x10).
1013 + 200 x (**N**-1)	SW	Higher alarm threshold for temperature with TC_K sensor of channel N in the set measurement unit (x10).
1014 + 200 x (**N**-1)	SW	Lower alarm threshold for **TEMPERATURE** with **TC_J** sensor of channel **N** in the set measurement unit (x10).
1015 + 200 x (**N**-1)	SW	Higher alarm threshold for temperature with TC_J sensor of channel N in the set measurement unit (x10).
1016 + 200 x (**N**-1)	SW	Lower alarm threshold for **TEMPERATURE** with **TC_T** sensor of channel **N** in the set measurement unit (x10).
1017 + 200 x (**N**-1)	SW	Higher alarm threshold for temperature with TC_T sensor of channel N in the set measurement unit (x10).
1018 + 200 x (**N**-1)	SW	Lower alarm threshold for **TEMPERATURE** with **TC_N** sensor of channel **N** in the set measurement unit (x10).
1019 + 200 x (**N**-1)	SW	Higher alarm threshold for temperature with TC_N sensor of channel N in the set measurement unit (x10).
1026 + 200 x (**N**-1)	SW	Lower alarm threshold for **TEMPERATURE** with **TC_E** sensor of channel **N** in the set measurement unit (x10).
1027 + 200 x (**N**-1)	SW	Higher alarm threshold for temperature with TC_E sensor of channel N in the set measurement unit (x10).
1028 + 200 x (**N**-1)	SW	Channel **N** lower alarm threshold in **mV** (x10). Only if channel **N** is configured as **0...1 V** input.
1029 + 200 x (**N**-1)	SW	Channel **N** higher alarm threshold in mV (x10). Only if channel **N** is configured as 0...1 V input.

Address	Type	Holding Register description
1030 + 200x(**N**-1)	SW	Channel **N** lower alarm threshold in **mV** (x100). Only if channel **N** is configured as **0...50 mV** input.
1031 + 200x(**N**-1)	SW	Channel **N** higher alarm threshold in mV (x100). Only if channel **N** is configured as 0…50 mV input.
1032 + 200x(**N**-1)	SW	Channel **N** lower alarm threshold in **mA** (x100). Only if channel **N** is configured as 4…20 mA input.
1033 + 200x(**N**-1)	SW	Channel **N** higher alarm threshold in mA (x100). Only if channel **N** is configured as 4…20 mA input.
1034 + 200x(**N**-1)	SW	Channel **N** lower alarm threshold in **%**. Only if channel **N** is configured as potentiometric input.
1035 + 200x(**N**-1)	SW	Channel **N** higher alarm threshold in **%**. Only if channel **N** is configured as potentiometric input.
1036 + 200x(**N**-1)	SW	Lower alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as 0…1 V input.
1037 + 200x(**N**-1)	SW	Higher alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as 0…1 V input.
1038 + 200x(**N**-1)	SW	Lower alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as 0…50 mV.
1039 + 200x(**N**-1)	SW	Higher alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as 0…50 mV.
1040 + 200x(**N**-1)	SW	Lower alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as 4…20 mA.
1041 + 200x(**N**-1)	SW	Higher alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as 4…20 mA.
1042 + 200x(**N**-1)	SW	Lower alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as potentiometric input.
1043 + 200x(**N**-1)	SW	Higher alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as potentiometric input.
1044 + 200x(**N**-1)	SW	Channel **N** lower alarm threshold in **mV**. Only if channel **N** is configured as **0...10 V** input.
1045 + 200x(**N**-1)	SW	Channel **N** higher alarm threshold in mV. Only if channel **N** is configured as 0…10 V input.
1046 + 200x(**N**-1)	SW	Lower alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as 0…10 V input.
1047 + 200x(**N**-1)	SW	Higher alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as 0…10 V input.
1048 + 200x(**N**-1)	SW	Lower alarm threshold of the **Nth** quantity acquired from digital bus
1049 + 200x(**N**-1)	SW	Higher alarm threshold of the **Nth** quantity acquired from digital bus
1050 + 200x(**N**-1)	SW	Channel **N** lower alarm threshold in **mV** (x100). Only if channel **N** is configured as **-50...50 mV** input.
1051 + 200x(**N**-1)	SW	Channel **N** higher alarm threshold in mV (x100). Only if channel **N** is configured as -50…50 mV input.
1052 + 200x(**N**-1)	SW	Lower alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as -50…50 mV.
1053 + 200x(**N**-1)	SW	Higher alarm threshold expressed as value of the quantity associated to channel **N** when the channel is configured as -50…50 mV.
1054 + 200x(**N**-1)	SW	Lower alarm threshold for **FIR** (Far Infrared) **RADIATION** in **W/m²** of channel **N** when the channel is configured as **Pyrgeometer** input.
1055 + 200x(**N**-1)	SW	Higher alarm threshold for FIR (Far Infrared) radiation in W/m² of channel N when the channel is configured as Pyrgeometer input.
Alarm thresholds for rainfall counters		
4008 & 4009	SW	**RAINFALL QUANTITY** (HD52.3DT…) lower alarm threshold in the set measurement unit. Register 4009 contains the most significant bits.

Address	Type	Holding Register description
4010 & 4011	SW	Rainfall quantity (HD52.3DT…) higher alarm threshold in the set measurement unit. Register 4009 contains the most significant bits.
4012 & 4013	SW	**DAILY RAINFALL QUANTITY** lower alarm threshold in the set measurement unit. Register 4013 contains the most significant bits.
4014 & 4015	SW	Daily rainfall quantity higher alarm threshold in the set measurement unit. Register 4015 contains the most significant bits.
General information		
10000 to 10019	B	User code with ASCII codification. Acceptable values are in the set {32,…,126}.
10020	W	Current year
10021	W	Current month
10022	W	Current day
10023	W	Current hour
10024	W	Current minute
10025	W	Current second
10026	W	Measurement interval: 0=1s, 1=2s, 2=5s, 3=10s, 4=15s, 5=30s, 6=1min, 7=2min, 8=5min, 9=10min, 10=15min, 11=30min, 12=1h
10027	W	Logging/RF interval: 0=1s, 1=2s, 2=5s, 3=10s, 4=15s, 5=30s, 6=1min, 7=2min, 8=5min, 9=10min, 10=15min, 11=30min, 12=1h
10032	W	Temperature measurement unit: 0=°C, 1=°F
10033	W	Atmospheric pressure measurement unit: see TAB 12.1.
10034	W	Baud rate RS485: 0=9600, 1=19200, 3=38400, 4=57600, 5=115200 bit/s
10035	W	RS485 communication mode: 0=8N1, 1=8N2, 2=8E1, 3=8E2, 4=8O1, 5=8O2
10036	W	Password to be supplied to enable configuration change commands. The reading provides the fixed value 32768.
10037 to 10046	B	Device group with ASCII codification. Acceptable values are in the set {32,…,126}.
10047	W	Wind speed measurement unit: see TAB 12.1.
10048	W	Rainfall quantity measurement unit: see TAB 12.1.
10051	W	Rain gauge resolution, in thousandths of mm *Example*: 0200 ⇒ 0.200 mm
10052	W	Setting of the quantities to be displayed in the automatic viewing cycle. Set the i-th bit (starting from LSB) to 1 if you wish to include the i-th quantity in the viewing cycle. *Example*: if in the model measuring and calculating: 1=Temp., 2=RH, 3=Td, 4=PVP, 5=Mix.Ratio, 6=AH, 7=Tw, the register is set to 0000 0000 0010 0010, only the relative humidity (RH) and the absolute humidity (AH) will be displayed alternatively.
10053	W	Setting of the RF quantities (RSSI, PER%) to be displayed in the automatic viewing cycle. Set the i-th bit (starting from LSB) to 1 if you wish to include the i-th RF quantity in the viewing cycle.
10064	W	Modbus address.
20000 to 20011	B	User code with ASCII codification of measurement #1. Available for models with more measurements of the same type.
20012 to 20023	B	User code with ASCII codification of measurement #2. Available for models with more measurements of the same type.
20024 to 20035	B	User code with ASCII codification of measurement #3. Available for models with more measurements of the same type.
20036 to 20047	B	User code with ASCII codification of measurement #4. Available for models with more measurements of the same type.
20048 to 20059	B	User code with ASCII codification of measurement #5. Available for models with more measurements of the same type.
20060 to 20071	B	User code with ASCII codification of measurement #6. Available for models with more measurements of the same type.

Address	Type	Holding Register description
20072 to 20083	B	User code with ASCII codification of measurement #7. Available for models with more measurements of the same type.
20084 to 20095	B	User code with ASCII codification of measurement #8. Available for models with more measurements of the same type.
20096 to20107	B	User code with ASCII codification of measurement #9. Available for models with more measurements of the same type.
20108 to 20119	B	User code with ASCII codification of measurement #10. Available for models with more measurements of the same type.
20120 to 20131	B	User code with ASCII codification of measurement #11. Available for models with more measurements of the same type.
20132 to 20143	B	User code with ASCII codification of measurement #12. Available for models with more measurements of the same type.

13 STORAGE OF INSTRUMENTS

Storage conditions of the instruments:

- Temperature: -40…+70 °C.
- Humidity: less than 90 %RH no condensation.
- For storage, avoid places where:
    - There is a high level of humidity;
    - Instruments are exposed to direct sun radiation;
    - Instruments are exposed to a high temperature source;
    - There are strong vibrations;
    - There is vapor, salt and/or corrosive gases.

14 SAFETY INSTRUCTIONS

General instructions for safety

These instruments have been manufactured and tested in compliance with the safety standards EN61010-1:2010 for electronic instruments of measure and left the factory in perfect safety technical conditions.

The regular functioning and operational safety of these instruments can be ensured only if all normal safety measures, as well as the specific measures described in this manual, are followed.

The regular functioning and operational safety of the instruments can only be guaranteed under the climatic conditions specified in the manual.

Do not use the instruments in places where there are:

- Corrosive or flammable gases.
- Direct vibrations or bumps to the instrument.
- High-intensity electromagnetic fields, static electricity.

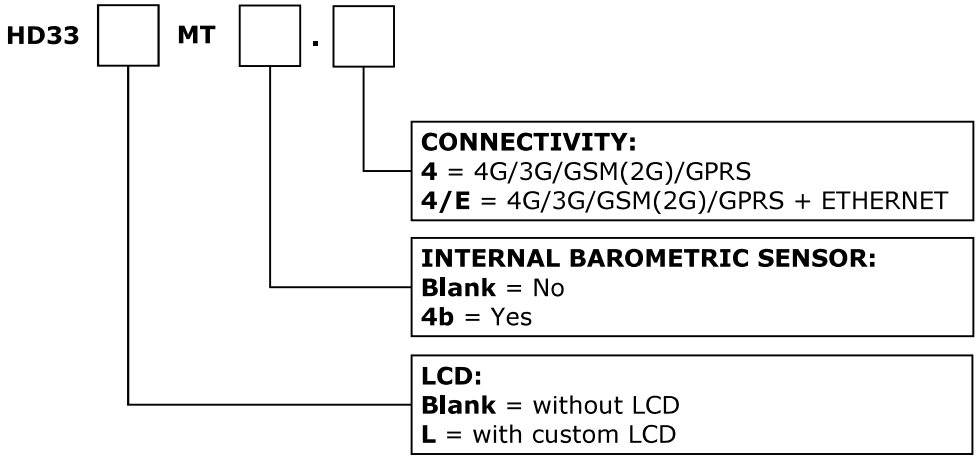
Obligations of the User

The user of the instruments must ensure compliance with the following standards and guidelines for the treatment of hazardous materials:

- EEC directives on workplace safety
- National low regulations on workplace safety
- Accident prevention regulations

15 ORDERING CODES

HD33[L]MT…. Data logger for weather station with mobile communication module. Stores measurements in the internal memory. Transmits the acquired data via FTP, via e-mail or to an HTTP server (Cloud). **Optional** LCD Display. SDI-12 and Master or Slave RS485 MODBUS-RTU connection. Connection to ETHERNET network with MODBUS TCP/IP protocol through **optional** module. Alarm functions. It includes **HD35AP-S** software downloadable from Delta OHM web site.
The battery, the probes and the USB cable CP23 have to be ordered separately. SIM card not included.



ACCESSORIES

HD35AP-CFR21 Advanced version of the HD35AP-S software for the management of the data logging system in accordance with the **FDA 21 CFR part 11 recommendations**.

CP23 Direct USB connection cable with mini-USB male connector on the instrument side and A-type USB male connector on the PC side.

HD32MT.SWD 100…240 Vac / 24 Vdc (adjustable) power supply unit with switch. IP 65 housing. Suitable for fastening to a rod. Includes fastening accessories.

BAT12V-3.4A 12 V / 3.4 Ah lead-acid rechargeable battery.

HD2005.20 Tripod kit with adjustable legs for installing environmental sensors (pyranometers, temperature and humidity, etc.). Material: anodized aluminum. Max. height 225 cm. It can be fixed on a flat base with screws or to the ground with pegs. Foldable legs for the transport.

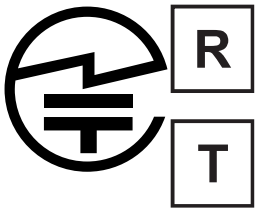
HD2005.20.1 Tripod kit with adjustable legs for installing environmental sensors (pyranometers, temperature and humidity, etc.). Material: anodized aluminum. Max. height 335 cm. It can be fixed on a flat base with screws or to the ground with pegs. Foldable legs for the transport.

Delta OHM has a wide range of sensors for measuring environmental physical quantities. Please visit www.deltaohm.com or contact Delta OHM directly.

DELTA OHM metrology laboratories LAT N° 124 are accredited ISO/IEC 17025 by ACCREDIA for Temperature, Humidity, Pressure, Photometry / Radiometry, Acoustics and Air Velocity. They can supply calibration certificates for the accredited quantities.

Approvals

HD33[L]MT**.4** contains LTE module FCC ID: XMR201903EG25G
IC ID: 10224A-201903EG25G
ANATEL: 02828-19-07968
TELEC certified RF module: [R] 201-190133



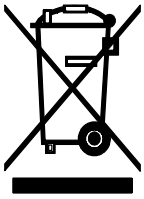
WARRANTY

The manufacturer is required to respond to the "factory warranty" only in those cases provided by Legislative Decree 6 September 2005 - n. 206. Each instrument is sold after rigorous inspections; if any manufacturing defect is found, it is necessary to contact the distributor where the instrument was purchased from. During the warranty period (24 months from the date of invoice) any manufacturing defects found will be repaired free of charge. Misuse, wear, neglect, lack or inefficient maintenance as well as theft and damage during transport are excluded. Warranty does not apply if changes, tampering or unauthorized repairs are made on the product. Solutions, probes, electrodes and microphones are not guaranteed as the improper use, even for a few minutes, may cause irreparable damages.
The manufacturer repairs the products that show defects of construction in accordance with the terms and conditions of warranty included in the manual of the product. For any dispute, the competent court is the Court of Padua. The Italian law and the "Convention on Contracts for the International Sales of Goods" apply.

TECHNICAL INFORMATION

The quality level of our instruments is the result of the continuous product development. This may lead to differences between the information reported in the manual and the instrument you have purchased.
We reserves the right to change technical specifications and dimensions to fit the product requirements without prior notice.

DISPOSAL INFORMATION

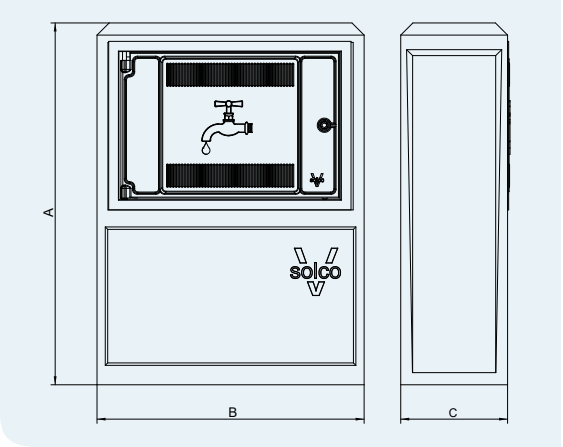


Electrical and electronic equipment marked with specific symbol in compliance with 2012/19/EU Directive must be disposed of separately from household waste. European users can hand them over to the dealer or to the manufacturer when purchasing a new electrical and electronic equipment, or to a WEEE collection point designated by local authorities. Illegal disposal is punished by law.

Disposing of electrical and electronic equipment separately from normal waste helps to preserve natural resources and allows materials to be recycled in an environmentally friendly way without risks to human health.

CE RoHS

Armario de Hormigón Puerta de Chapa



CARACTERÍSTICAS TÉCNICAS

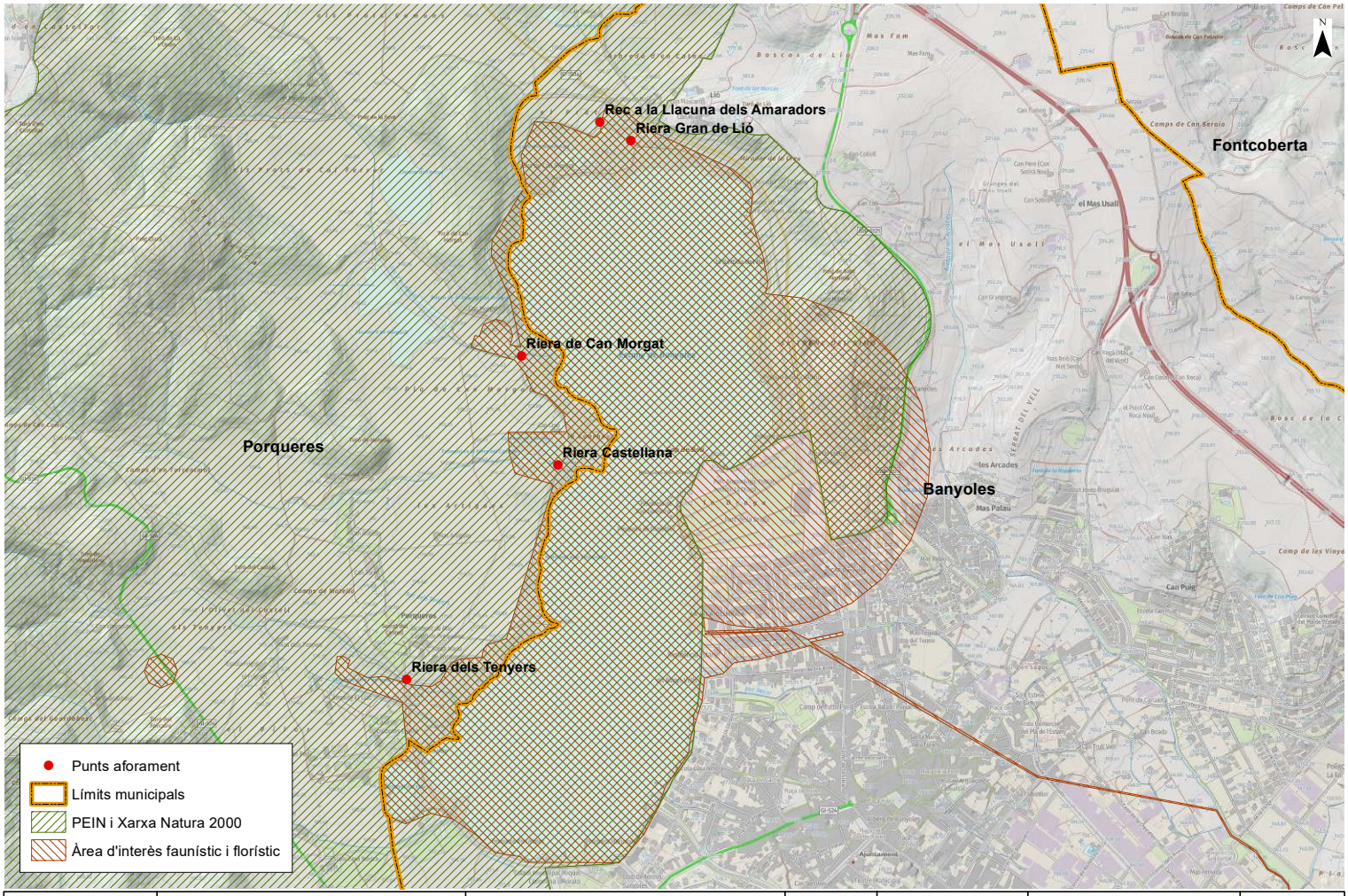
- Armario fabricado con hormigón reforzado con fibra de vidrio ofreciendo una gran resistencia al impacto.
- Disponibilidad de modelos con puerta de chapa galvanizada con recubrimiento de pintura epoxi en polvo secada al horno.
- Cierre mediante pestillo en acero inoxidable accionado por un eje de latón cromado, con diferentes tipos: allen, triangular y SGAB
- Las puertas de poliéster pueden venir suministradas con aislamiento al igual que el conjunto de cofre y puerta que se puede suministrar con aislamiento total.
- La base del armario totalmente abierta, facilita la colocación de tubos de entrada y salida al contador u otros mecanismos. La pared trasera del armario viene prevista de unos orificios fácilmente practicables para otro tipo de montajes.

Codigo	Tipo Cierre	Alojamiento	Medida Puerta	A mm.	B mm.	C mm.	Aislamiento	Unidades pallet
A-AH-PC4040	Allen	Puerta Chapa	400x400	750	540	220	-	10
A-AH-PC5060	Allen	Puerta Chapa	500x600	850	680	330	-	3
A-AH-PCS5060	SGAB	Puerta Chapa	500x600	850	680	330	-	3
A-AH-PCT5060	Triangular	Puerta Chapa	500x600	850	680	330	-	3

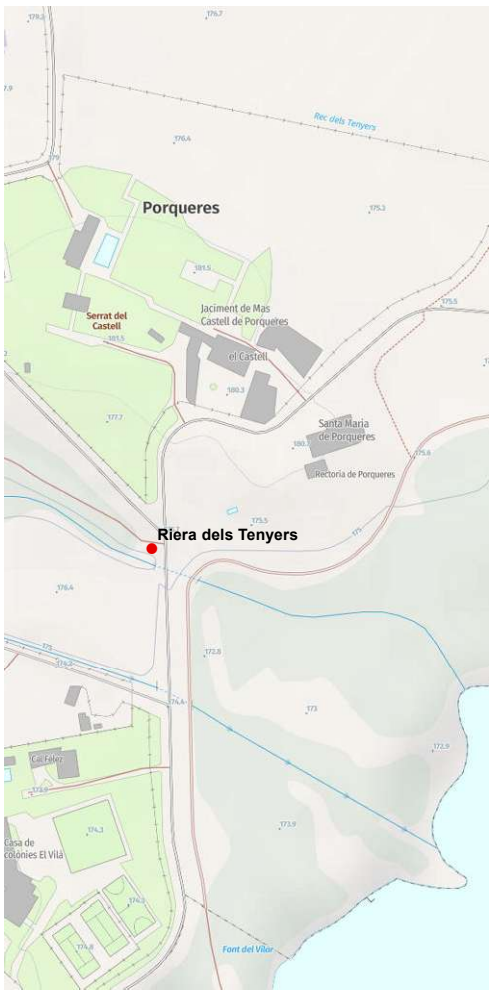
DOCUMENT NÚM. 2

PLÀNOLS

Finançat per
Unió Europea
Fons Europeu
Next Generation
GOBIERNO DE ESPAÑA
Pla de Recuperació, Transformació i Resiliència
Next Generation Catalunya
Generalitat de Catalunya

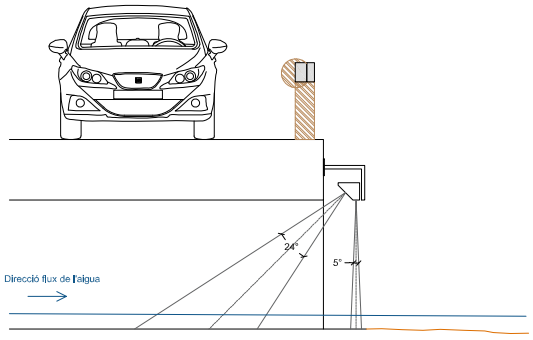


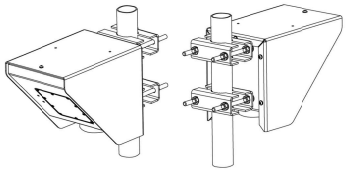
PROMOU:	REDACTA:	TÍTOL DEL PROJECTE:	DATA:	ESCALA:	TÍTOL DEL PLÀNOL:	PLÀNOL NÚM:
	Josep Aleix Comas i Herrera Eng. de Camins, Canals i Ports Col·legiat 18.188	SISTEMA D'AFORAMENT DE LES RIERES I RECS D'ENTRADA A L'ESTANY DE BANYOLES	Octubre 2025	A3: 1:10.000 0 100 200 m	SITUACIÓ	1

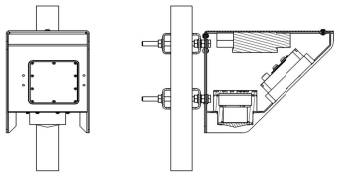


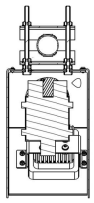
PROMOU:	REDACTA: Josep Aleix Comas i Herrera Eng. de Camins, Canals i Ports Col·legiat 18.188	TÍTOL DEL PROJECTE: SISTEMA D'AFORAMENT DE LES RIERES I RECS D'ENTRADA A L'ESTANY DE BANYOLES	DATA: Octubre 2025	ESCALA: A3: 1:2.000 0 25 50 m	TÍTOL DEL PLÀNOL: EMPLAÇAMENT	PLÀNOL NÚM: 2

RIERA CASTELLANA I RIERA DE CAN MORGAT



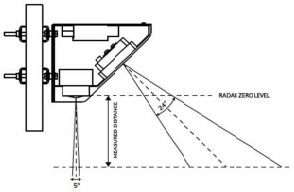




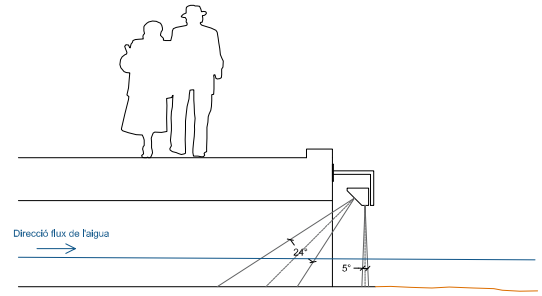


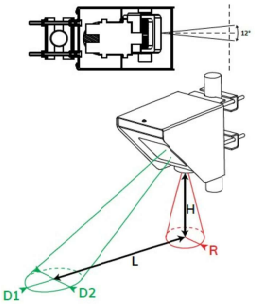
Radar de microones per mesura de velocitat i nivell de l'aigua.
Instal·lació fora l'estructura hidràulica i per sobre la cota superior de la llum de la mateixa.
Radar orientat cap a dins l'estructura hidràulica i cap a la direcció contrària al flux de l'aigua.

Radar ancorat a la llinda de l'obra de l'estructura hidràulica amb braç d'acer tubular de 30x30 mm de secció, ancorat amb placa de 200x200 mm i cargols amb tac químic.



REC GRAN DE LIÓ

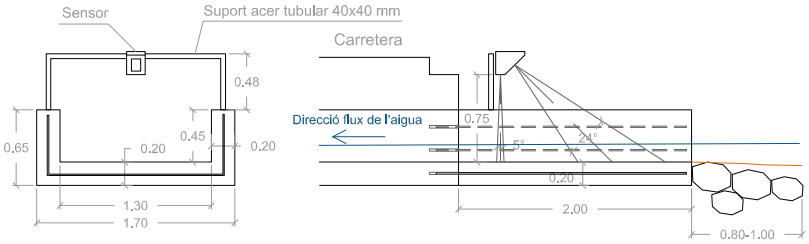


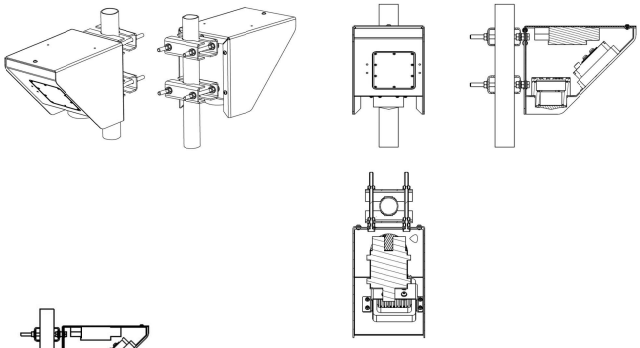


Height [H]	L [m]	D1 [m]	D2 [m]	R [m]
0.3 m	0.3	0.3	0.2	0.03
0.5 m	0.5	0.5	0.3	0.04
1 m	1.0	0.9	0.3	0.09
2 m	2.0	1.8	0.6	0.17
3 m	3.0	2.7	0.9	0.26
4 m	4.0	3.6	1.2	0.35
5 m	5.0	4.5	1.5	0.44
6 m	6.0	5.3	1.8	0.52
7 m	7.0	6.2	2.1	0.61
8 m	8.0	7.1	2.4	0.70
9 m	9.0	8.0	2.7	0.79
10 m	10.0	8.9	3.0	0.87
11 m	11.0	9.8	3.3	0.96
12 m	12.0	10.7	3.6	1.05
13 m	13.0	11.6	3.9	1.14
14 m	14.0	12.5	4.2	1.22
15 m	15.0	13.4	4.5	1.31

Promou		Títol del projecte	Data	Escala	Títol del plànol	Plànol núm.
	SERPA ENGINYERIA I CONSULTORIA AMBIENTAL, SL JOSEP ALEIX COMAS I HERRERA Enginyer de Camins, Canals i Ports Col. Núm. 18188	SISTEMA D'AFORAMENT DE LES RIERES I RECS D'ENTRADA A L'ESTANY DE BANYOLES	Octubre 2025	s/e	SENSORS EN ESTRUCTURES HIDRÀULIQUES	3

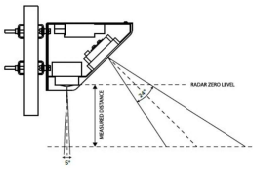
RIERA DELS TENYERS



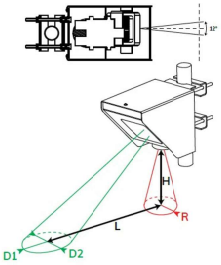


Nou canal de formigó armat amb barra acer Ø12 mm, ancorat a estructura de formigó existent amb barra d'acer Ø12 mm i resines epoxi.
A l'entrega del canal de formigó amb la llera es col·locarà pedra d'escullera petita (100-400 kg) solta per protegir la llera de l'erosió.

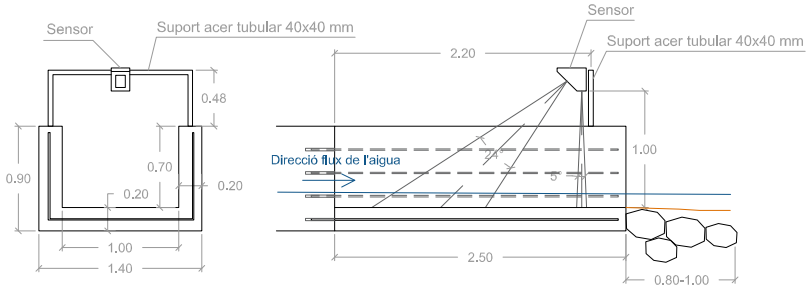
Radar de microones per mesura de velocitat i nivell de l'aigua.
Instal·lat sobre marc d'acer tubular de 40x40 mm ancorat al canal de formigó.
Radar orientat cap a la direcció contrària al flux de l'aigua.



Height [H]	L [m]	D1 [m]	D2 [m]	R [m]
0.3 m	0.3	0.3	0.2	0.03
0.5 m	0.5	0.5	0.3	0.04
1 m	1.0	0.9	0.3	0.09
2 m	2.0	1.8	0.6	0.17
3 m	3.0	2.7	0.9	0.26
4 m	4.0	3.6	1.2	0.35
5 m	5.0	4.5	1.5	0.44
6 m	6.0	5.3	1.8	0.52
7 m	7.0	6.2	2.1	0.61
8 m	8.0	7.1	2.4	0.70
9 m	9.0	8.0	2.7	0.79
10 m	10.0	8.9	3.0	0.87
11 m	11.0	9.8	3.3	0.96
12 m	12.0	10.7	3.6	1.05
13 m	13.0	11.6	3.9	1.14
14 m	14.0	12.5	4.2	1.22
15 m	15.0	13.4	4.5	1.31



REC A L'ESTANYOL DELS AMARADORS



Promou		JOSEP ALEIX COMAS I HERRERA Enginyer de Camins, Canals i Ports Col. Núm. 18188	Títol del projecte	Data	Escala	Títol del plànol	Plànol núm.
	SERPA ENGINYERIA I CONSULTORIA AMBIENTAL, SL		SISTEMA D'AFORAMENT DE LES RIERES I RECS D'ENTRADA A L'ESTANY DE BANYOLES	Octubre 2025	s/e	SENSORS EN TRAM CANALITZAT	4

DOCUMENT NÚM. 3

PRESSUPOST

Finançat per
Unió Europea
Fons Europeu
Next Generation
GOBIERNO DE ESPAÑA
Pla de Recuperació, Transformació i Resiliència
Next Generation Catalunya
Generalitat de Catalunya

AMIDAMENTS

Data: 12/03/26 Pàg.: 1

Obra 01 PRESSUPOST AFORAMENT DE RECS I RIERES ALIMENTACIÓ ESTANY DE B
Capítol 01 MATERIALS ACCESORIS

NUM.	CODI	UA	DESCRIPCIÓ
1	XPA01PRE2	u	Canal de formigó prefabricat armat, de 2000x1700x650 mm de mesures exteriors i 2000x1300x450 mm de mesures interiors, armat amb barra d'acer, segons plànols i memòria.

Num.	Text	Tipus	[C]	[D]	[E]	[F]	TOTAL	Fórmula
1	Canal inst. riera dels Tenyers		1,000				1,000	C#*D#*E#*F#

TOTAL AMIDAMENT **1,000**

2	XPA01PREF	u	Canal de formigó prefabricat armat, de 2500x1400x900 mm de mesures exteriors i 2500x1000x700 mm de mesures interiors, armat amb barra d'acer, segons plànols i memòria.

Num.	Text	Tipus	[C]	[D]	[E]	[F]	TOTAL	Fórmula
1	Canal pref. inst. rec a la Llacuna dels Amaradors		1,000				1,000	C#*D#*E#*F#

TOTAL AMIDAMENT **1,000**

3	P4B0-6097	u	Barres corrugades de 12 mm de diàmetre

Num.	Text	Tipus	[C]	[D]	[E]	[F]	TOTAL	Fórmula
1	Rec a l'Estanyol dels Amaradors		14,000				14,000	C#*D#*E#*F#
2	Riera dels Tenyers		13,000				13,000	C#*D#*E#*F#

TOTAL AMIDAMENT **27,000**

4	PXXX-6097	Kg	Adhesiu de resines epoxi sense dissolvents, de dos components i baixa viscositat, per a ús estructur

AMIDAMENT DIRECTE **2,700**

Obra 01 PRESSUPOST AFORAMENT DE RECS I RIERES ALIMENTACIÓ ESTANY DE B
Capítol 02 ARMARIS

NUM.	CODI	UA	DESCRIPCIÓ
1	PG2N-EUGU	m	Tub corbable corrugat de polietilè, de doble capa, llisa la interior i corrugada l'exterior, de 40 mm de diàmetre nominal, aïllant i no propagador de la flama, resistència a l'impacte de 15 J, resistència a compressió de 450 N

Num.	Text	Tipus	[C]	[D]	[E]	[F]	TOTAL	Fórmula
1	Tub passar cables entre armari i aparells		12,000	5,000			60,000	C#*D#*E#*F#

TOTAL AMIDAMENT **60,000**

2	PG1X-FOR1	u	Subministrament i instal·lació d'armari de formigó prefabricat de 850x680x330 mm per a servei exterior, porta de xapa d'acer de 500x600 mm amb escletxes per a ventilació i pany anti bandalisme.

AMIDAMENT DIRECTE **5,000**

3	P89B-ARMA	m2	Aplicació d'oxidant de formigó per a estructures de formigó

Num.	Text	Tipus	[C]	[D]	[E]	[F]	TOTAL	Fórmula
1			1,500	2,000	5,000		15,000	C#*D#*E#*F#

AMIDAMENTS

TOTAL AMIDAMENT **15,000**

Obra 01 PRESSUPOST AFORAMENT DE RECS I RIERES ALIMENTACIÓ ESTANY DE B
Capítol 03 SENSOR I DATALOGGER

NUM.	CODI	UA	DESCRIPCIÓ
1	PMR1-CABA	u	Cabalímetre tipus radar de microones per a un rang de 0,2 m a 15 m, resolució del nivell d'aigua de 0,5 mm i resolució de velocitat de l'aigua 0,001 m/s, amb comunicació 4G - sistema RS-232/485, SDI-12 analògic, 4-20 mA, amb carcassa d'alumini anoditzat i temperatura de funcionament -40ºC a 85ºC, tipus Geolux RSS-2-300WL o equivalent.

AMIDAMENT DIRECTE **5,000**

2	PP7A-DTLG	u	Datalogger4G amb LCD, 4 entrades analògiques i 2 entrades digitals, 2 sortides digitals RS-485, SDI-12. Dins caixa de protecció de 170x270x110 mm.

AMIDAMENT DIRECTE **5,000**

3	XPA02SHEL	u	Sistema de protecció del sistema amb kit de muntatge d'acer IP-66 de 400x600x200 mm

AMIDAMENT DIRECTE **5,000**

Obra 01 PRESSUPOST AFORAMENT DE RECS I RIERES ALIMENTACIÓ ESTANY DE B
Capítol 04 ALIMENTACIÓ ELÈCTRICA

NUM.	CODI	UA	DESCRIPCIÓ
1	PG16-E3HZ	u	Caixa de doble aïllament de polièster reforçat, de 540x360x210 mm, col·locació superficial

Num.	Text	Tipus	[C]	[D]	[E]	[F]	TOTAL	Fórmula
1	Caixa de protecció per a la bateria		5,000				5,000	C#*D#*E#*F#

TOTAL AMIDAMENT **5,000**

2	PMR1-CABR	u	Carregador de bateria recarregable 100 Ah, 12V

AMIDAMENT DIRECTE **1,000**

3	PMR1-CHHG	u	Bateria recarregable 150 Ah, 12V

AMIDAMENT DIRECTE **7,000**

PRESSUPOST

Data: 13/03/26 Pàg.: 1

Obra 01 Pressupost AFORAMENT DE RECS I RIERES ALIMENTACIÓ ESTANY DE B
Capítol 01 MATERIALS ACCESORIS

NUM.	CODI	UA	DESCRIPCIÓ	PREU	AMIDAMENT	IMPORT
1	XPA01PRE2	u	Canal de formigó prefabricat armat, de 2000x1700x650 mm de mesures exteriors i 2000x1300x450 mm de mesures interiors, armat amb barra d'acer, segons plànols i memòria. (P - 0)	1.338,98	1,000	1.338,98
2	XPA01PREF	u	Canal de formigó prefabricat armat, de 2500x1400x900 mm de mesures exteriors i 2500x1000x700 mm de mesures interiors, armat amb barra d'acer, segons plànols i memòria. (P - 0)	1.047,04	1,000	1.047,04
3	P4B0-6097	u	Barres corrugades de 12 mm de diàmetre (P - 1)	0,89	27,000	24,03
4	PXXX-6097	Kg	Adhesiu de resines epoxi sense dissolvents, de dos components i baixa viscositat, per a ús estructur (P - 10)	28,75	2,700	77,63
TOTAL	**Capítol**		**01.01**			**2.487,68**

Obra 01 Pressupost AFORAMENT DE RECS I RIERES ALIMENTACIÓ ESTANY DE B
Capítol 02 ARMARIS

NUM.	CODI	UA	DESCRIPCIÓ	PREU	AMIDAMENT	IMPORT
1	PG2N-EUGU	m	Tub corbable corrugat de polietilè, de doble capa, llisa la interior i corrugada l'exterior, de 40 mm de diàmetre nominal, aïllant i no propagador de la flama, resistència a l'impacte de 15 J, resistència a compressió de 450 N (P - 5)	1,51	60,000	90,60
2	PG1X-FOR1	u	Subministrament i instal·lació d'armari de formigó prefabricat de 850x680x330 mm per a servei exterior, porta de xapa d'acer de 500x600 mm amb escletxes per a ventilació i pany anti bandalisme. (P - 4)	472,60	5,000	2.363,00
3	P89B-ARMA	m2	Aplicació d'oxidant de formigó per a estructures de formigó (P - 2)	4,96	15,000	74,40
TOTAL	**Capítol**		**01.02**			**2.528,00**

Obra 01 Pressupost AFORAMENT DE RECS I RIERES ALIMENTACIÓ ESTANY DE B
Capítol 03 SENSOR I DATALOGGER

NUM.	CODI	UA	DESCRIPCIÓ	PREU	AMIDAMENT	IMPORT
1	PMR1-CABA	u	Cabalímetre tipus radar de microones per a un rang de 0,2 m a 15 m, resolució del nivell d'aigua de 0,5 mm i resolució de velocitat de l'aigua 0,001 m/s, amb comunicació 4G - sistema RS-232/485, SDI-12 analògic, 4-20 mA, amb carcassa d'alumini anoditzat i temperatura de funcionament -40ºC a 85ºC, tipus Geolux RSS-2-300WL o equivalent. (P - 6)	5.485,80	5,000	27.429,00
2	PP7A-DTLG	u	Datalogger4G amb LCD, 4 entrades analògiques i 2 entrades digitals, 2 sortides digitals RS-485, SDI-12. Dins caixa de protecció de 170x270x110 mm. (P - 9)	1.743,75	5,000	8.718,75
3	XPA02SHEL	u	Sistema de protecció del sistema amb kit de muntatge d'acer IP-66 de 400x600x200 mm (P - 0)	569,41	5,000	2.847,05
TOTAL	**Capítol**		**01.03**			**38.994,80**

Obra 01 Pressupost AFORAMENT DE RECS I RIERES ALIMENTACIÓ ESTANY DE B
Capítol 04 ALIMENTACIÓ ELÈCTRICA

PRESSUPOST

Data: 13/03/26 Pàg.: 2

NUM.	CODI	UA	DESCRIPCIÓ	PREU	AMIDAMENT	IMPORT
1	PG16-E3HZ	u	Caixa de doble aïllament de polièster reforçat, de 540x360x210 mm, col·locació superficial (P - 3)	164,97	5,000	824,85
2	PMR1-CABR	u	Carregador de bateria recarregable 100 Ah, 12V (P - 7)	694,96	1,000	694,96
3	PMR1-CHHG	u	Bateria recarregable 150 Ah, 12V (P - 8)	385,00	7,000	2.695,00
TOTAL	**Capítol**		**01.04**			**4.214,81**

RESUM DE PRESSUPOST

NIVELL 2 : Capítol			Import
Capítol	01.01	MATERIALS ACCESORIS	2.487,68
Capítol	01.02	ARMARIS	2.528,00
Capítol	01.03	SENSOR I DATALOGGER	38.994,80
Capítol	01.04	ALIMENTACIÓ ELÈCTRICA	4.214,81
Obra	**01**	**Pressupost**	**48.225,29**
			48.225,29

NIVELL 1 :		Import
——	Pressupost Subministrament	48.225,29
		48.225,29

PRESSUPOST

PRESSUPOST SUBMNISTRAMENT.....		48.225,29
	Subtotal	48.225,29
21 % IVA SOBRE 48.225,29.....		10.127,31
TOTAL PRESSUPOST	€	58.352,60

Aquest pressupost puja a

(CINQUANTA-VUIT MIL TRES-CENTS CINQUANTA-DOS EUROS AMB SEIXANTA CÈNTIMS)