ISAR User Manual v2.01

W. Wimmer
Ocean and Earth Science
National Oceanography Centre Southampton
University of Southampton Waterfront Campus
European Way, Southampton, SO14 3ZH, U.K.

Reference: ISAR-User-Manual-v2.01.docx
Issue: 2.01
Date of issue: July 2011
Document type: User Manual

Document change record

Author	Modification	Issue	Rev.	Date
C Donlon	Original	DRAFT	0.1	March 27, 2003
C Donlon	Updated to isaros-v6.1 data format	DRAFT	0.2	April 3rd 2003
C Donlon	Updated to isaros-v6.2 data format	DRAFT	0.3	April 22nd 2003
C Donlon	Updated to new isaros6.2 format	DRAFT	0.4	May 5th 2003
C Donlon	Updated with inputs from Gary Fisher	DRAFT	0.6	June 6th 2003
C Donlon	Included PNI setup and revised Encoder setup sections. Checked data format sections and updated to isaros-v6.7. Added prototy6pe optical alignment and prototype GPS configuration sections.	DRAFT	0.7	August 14th 2003
C Donlon	Added SCS enabled routines and data format description	DRAFT	0.8	November 10th 2003
C Donlon	Updated and corrected errors	DRAFT	0.9	January 20th 2004
C Donlon	Revised to isaros-v7.1	DRAFT	0.10	March 6th 2004
C Donlon & M Reynolds	Revised to isaros-v7.2 and redesigned outputs for SCS operations while in Miami building ISAR#1. Added new section describing hardware.	DRAFT	0.11	March 14th 2004
W Wimmer	Revised to isaros-v7.15	DRAFT	0.12	May 3rd 2005
W Wimmer	Revised with user comments (P. Minnett, E. Key)	Initial	1.00	March, 8th 2006
C Donlon, W. Wimmer, E Key and G Fisher	Revised at Miami ISAR/CASOTS-II intercalibration workshop. Round table discussion of the manual contents page by page		1.02	March 13th 2006
W Wimmer	Revised for isaros-v7.19		1.10	October, 11th 2007
I S Robinson	Editorial revisions to improve readability		1.11	October 15th 2007
J Hopkins	Revised for ISAR-5D electronics system. Revised for new ISOC and ISARTOOLS code. Table 2-1 updated for revised component list. Fig. 3-1 updated for 24v power supply. Table 3-1 updated with revised wiring schedule. Table 3-2 updated for revised wiring schedule. Table 3-3 updated for revised baud rate. References to TT8 on-board computer replaced with Eurotech Titan. Section 7 rewritten for new config file format. Section 8 updated for new data record format. Maintenance section removed & combined into new Procedures Manual v 1.0. Appendix C moved into new Section 9 and replaced with computer reset procedure Editorial revisions for improved readability.		2.01	July 2011

Table of contents

1 Introduction

The Infrared Sea surface temperature Autonomous Radiometer model 5 (ISAR-5) has been developed to provide accurate and reliable measurements of the radiative sea surface temperature (SSTskin) to an accuracy of ±0.1 K by measuring infrared emission from the sea surface and atmosphere in the spectral waveband 9.8-11.5μm (see Table 1.1), without the need for frequent operator intervention. One of the major problems with obtaining accurate SSTskin measurements from ships has been adequate environmental protection of delicate infrared radiometer fore-optics. Seawater spray or rain can introduce significant errors and in extreme cases, destroy instrumentation. The ISAR-5 system has been specifically designed to address these problems and to provide a self calibrating infra red radiometer system that can operate autonomously for extended periods when deployed from a ship of opportunity (SOO). As SSTskin measurements benefit from being supplemented by other coincident measurements in most applications, additional meteorological or oceanographic instrumentation can be connected to the ISAR-5 system to provide a complete user specified measurement package.

Table 1.1 ISAR-5D Instrument Specifications

Spectral range	9.6-11.5μm
Response time	0.05-10s (user defined)
SSTskin Accuracy[1]	±0.1K rmse.
Temperature range[2]	173-373 K
Target angle range	180° (nadir-zenith) in 0.1° intervals (user defined)
Maximum continuous deployment at sea	3 months
Min. deployment height	7m above sea level
Calibration type	2 internal radiance cavities
Output	RS232/NMEA style
Weight	Approx. 20 kg
Dimensions	Diameter 200mm x 500 mm
Operating temperature	274 - 310 K (non-freezing)
Power input	24V DC

This operations manual describes the configuration, operation and deployment of an ISAR-5[3] system. It is meant to be a user reference guide that provides sufficient information for you to configure and begin making measurements with the ISAR system. For more detailed advice on set up and maintenance procedures, please refer to the accompanying ISAR Procedures Manual.

Version 2 of this manual applies to an updated design of the instrument (designated ISAR-5D), which incorporates the new electronics system designed by W. Wimmer in 2009. Users of ISAR instruments based on the original electronics system (i.e. model ISAR-5C) should continue to refer to the ISAR User Manual v1.11.

The following symbols are used within this manual:

ⓘ Indicates useful information and tips to help you work with your ISAR

Indicates critical information that should be read carefully to avoid damage to the ISAR instrument.

1 Depending on the appropriate value for the emissivity of seawater
2 Contact the ISAR team for advice regarding the use of the instrument outside of this temperature range
3 Note that henceforward the user manual will refer to the ISAR-5 instrument as ISAR.

It is assumed that the user is competent in handling PC computers, software installation, basic Linux commands, basic wiring of plugs and has an understanding of the principles and methodology of making infrared measurements of the sea surface and atmosphere.

For further information regarding the premise behind the ISAR instrument, please refer to:

Donlon, C., Robinson, I.S., Reynolds, M., Wimmer, W., Fisher, G., Edwards, R. and Nightingale, T.J., 2008. An Infrared Sea Surface Temperature Autonomous Radiometer (ISAR) for deployment aboard Volunteer Observing Ships (VOS), *Journal of Atmospheric and Oceanic Technology*, **25,** pp. 93-113.

2 Unpacking the ISAR system

This section of the ISAR manual explains how to:

1. Unpack and repack the ISAR system and peripheral devices
2. Check for damaged items
3. Check that all components are present

The ISAR is shipped in a robust travel case that contains all of the necessary hardware and software to operate the ISAR instrument. However, as each deployment requires consideration of local mounting options, it will be necessary to construct a mounting cradle specific to your deployment. Please contact the ISAR team for advice on suitable mounting options. Operational deployment of ISAR on a ship demands careful thought and attention in terms of accessibility, measurement geometry, robust instrument mounting brackets etc. and is specific to each deployment. In general, ISAR should view the sea surface at an angle of ~25° from nadir (limiting the effect of angular variation of emissivity due to ship movements), at a position that is free of the ship's wake, and the distance between any subsurface systems and the ISAR measurement should be recorded.

ⓘ Handle all items with care and inspect each one for obvious damage. If you suspect that any ISAR component is damaged, please notify the ISAR team immediately.

Figure 2-1. The ISAR-5 radiometer and rain gauge.

Before you begin to use your ISAR, please take some time to check that your ISAR system is complete and that there are no obvious signs of damage. Use Table 2-1 to ensure that all items are present in the box when first unpacking and contact the ISAR team if any items are missing.

Documentation on various aspects and components of the ISAR system are available on the ISAR-5 CD-ROM.

Table 2-1. ISAR-5D component list.

Item code	Number supplied	Description
ISAR5D-C01	1	ISAR-5D instrument
ISAR5D-C02	1	Thies Clima precipitation sensor & cable (optical rain gauge)
ISAR5D-C03	1	Trimbell GPS magnetic antenna
ISAR5D-C04	1	Power & communications pigtail for ISAR-5D
ISAR5D-C05	1	KT15 lens mount for laser module
ISAR5D-C06	1	CD-ROM containing component operating manuals, software and documentation

3 Getting Started

3.1 Connecting the ISAR system

This section of the ISAR manual explains how to:

1. Connect the precipitation sensor to the ISAR instrument. (Please note that throughout this manual the precipitation sensor is referred to generically as the optical rain gauge or ORG).
2. Connect the GPS antennae to the ISAR instrument
3. Connect a power supply to the ISAR instrument
4. Connect external user RS485 devices to the ISAR instrument
5. Connect the ISAR to a computer

Figure 3-1 shows the electronics housing end cap of the ISAR-5D instrument and the necessary connections to the external devices. Use this as a guide to connect the ISAR-5D system noting the orientation of the ISAR-5D using the 4 LED indicators as a guide.

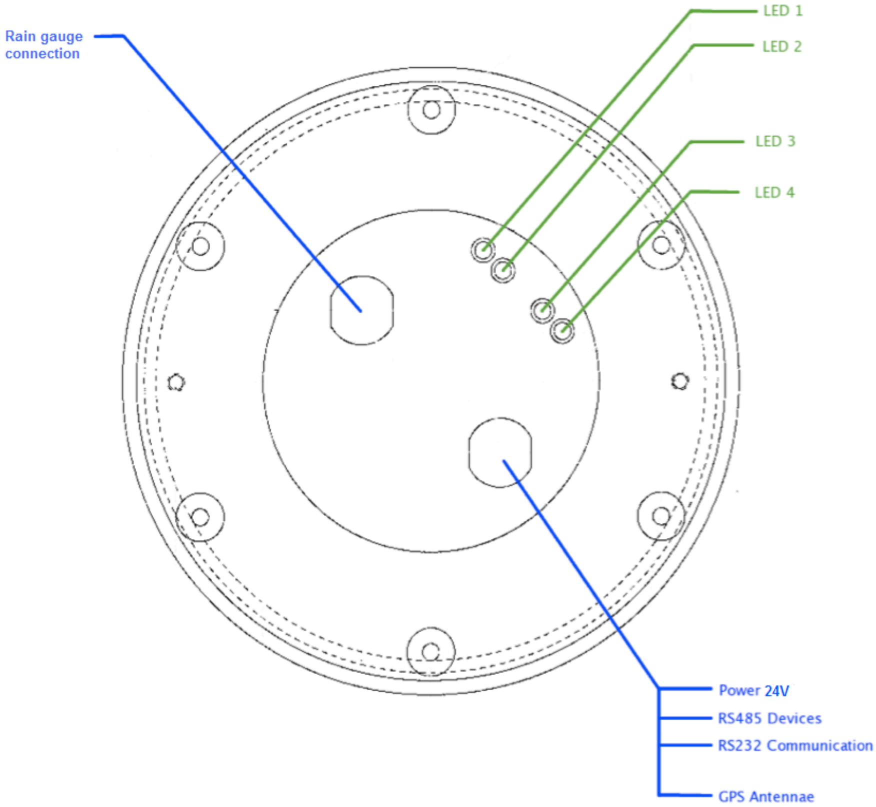


Figure 3-1 View of the ISAR end plate showing how external connections are made to the instrument. Use the position of the indicator panel lights to correctly orientate the ISAR-5D body.

Connect each of the peripheral devices to the ISAR instrument as shown in Figure 3-1 ensuring that the connections are well made. Wiring tables are given for each peripheral device in the following sections.

3.2 Peripheral device wiring schedule

3.2.1 Optical rain gauge wiring

The optical rain gauge socket is wired according to Table 3-1.

Table 3-1 Optical rain gauge socket wiring schedule

Pin number	Wire colour	Purpose
1	**Screen**	Not used
2	**Black**	Ground
3	**Purple**	Analogue Signal 1
4	**Yellow**	+12Volt DC
5	**Brown**	Analogue signal 2
6	**White**	Analogue Ground
7		Not used
8		Not used

3.2.2 Communication, Power and GPS antennae wiring

The communications interface, power and GPS antennae socket is wired according to Table 3-2.

Table 3-2 The communications interface, power and GPS antennae socket wiring schedule

Pin number	Wire colour	Purpose
Coax	**Black**	GPS antennae
1	**Red/Blue**	Not connected
2	**Orange/Green**	Not connected
3	**White/Green**	Not connected
4	**Yellow/Green**	Not connected
5	**White**	Ethernet TX + (1)
6	**Yellow**	Ethernet TX – (2)
7	**Black**	Ethernet RX + (3)
8	**Blue**	Ethernet RX – (6)
9	**Red**	RS422 TX +
10	**Cyan**	RS422 TX -
11	**White/Blue**	RS422 RX +
12	**Yellow/Green/Blue**	RS422 RX -
13	**Red/Brown**	RS 232 GND
14	**Pink**	RS 232 TX
15	**Purple**	RS 232 RX
16	**Green**	RS485 12V GND
17	**Brown**	RS485 12 V Power
18	**Grey**	RS485 TX +
19	**Green/Red**	RS485 RX -
20	**Yellow/Red**	POWER GND
21	**White/Red/ Orange**	POWER IN 24V
22	**Red/Black**	POWER GND

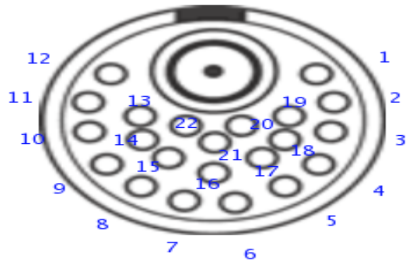


Figure 3-2: LEMO EGG.3K.822 socket view from the solder side.

Serial interface communication settings are shown in Table 3-3.

Table 3-3 Serial communications parameters for ISAR serial interface

Name	Setting
Baud	115200
Data Bits	8
Stop Bits	1
Parity	None
Handshake	None

The ISAR on-board computer is a Eurotech Titan manufactured by Eurotech. Further information can be found at http://eurotech-ltd.co.uk.

For operational deployments, use an uninterruptible power supply.

Ensure that the **correct voltage** is set on the power supply unit (24 V DC) Always use an uninterruptible power supply with a current limit facility. If the input power falls below 15V DC the on board computer may require a hard power reset (see Appendix C) as the internal registers may be corrupted. **This may be difficult to determine as the ISAR system and operational code may continue to operate. However, all data registers within the system may be corrupt and therefore the data will be incorrect!**

ISAR should draw about 0.5-0.7 A during normal operations and ~1 – 1.2 A during motor operations. If excessive current is drawn, immediately power off and contact the ISAR team for advice and assistance.

4 General precautions when handling your ISAR instrument

This section of the ISAR-5D manual describes how to work safely with your ISAR instrument and explains a number of precautions that should be taken prior to powering up your ISAR for the first time.

1. Double check that all connections to your ISAR are made correctly in accordance with section 3 of this manual.
2. Use an appropriate cradle to secure your ISAR before power up. The ISAR storm shutter may be damaged if not properly protected. Ensure that the shutter is free to rotate whilst in the laboratory or when deployed.
3. Be aware that the torque on the ISAR storm shutter is significant. There is a risk of severe injury if the user traps fingers in the ISAR storm shutter. In addition, significant damage to the storm shutter mechanism will occur if the shutter traps a foreign body.
4. The ISAR instrument is normally delivered with the storm shutter in the closed position.

   Be aware that this may open automatically on power up.
5. The RS485 connector carries 12 V DC power. Ensure that the contacts, as described in section 3.2.2, are properly isolated when not in use.
6. Be aware that the ISAR instrument weighs ~20 kg. Care should be taken when lifting or moving the instrument.
7. When the shutter is open, the scan drum unit will rotate to view various target views and each of the ISAR calibration blackbody units that are located inside the ISAR. It is normal for the scan drum to operate like this. Ensure that the scan drum aperture is protected from the ingress of foreign objects, as these may damage the ISAR scan mirror and Zinc Selenide window.

5 ISAR software installation

This section of the ISAR manual explains how to install the ISAR software on a computer that will be used to control the ISAR instrument

Install the operational software provided on the ISAR CD-ROM following the instructions provided in the README.TXT file. Typically, the ISAR code is copied to a directory with the structure defined in Table 5-1:

Table 5-1 Directory structure of the ISAR-5D software distribution

Directory structure	Contents and purpose
\doc\ISAR	Contains the ISAR manual
\doc\manuals	The manuals for the onboard computer, the PNI module and the Trimble GPS module
\software\ISOC	Contains Linux ARM executable files and ISARTOOLS file
\software\isarconf	Contains ISAR configuration file (these are instrument specific)
\software\IIDL	Contains the ISAR data logger software
\software\post_processing	Contains the ISAR post processing software and the instructions on how to install python.

In order to successfully communicate with ISAR via the serial port, the user must ensure that an appropriate serial terminal program (e.g. PuTTY) is installed on the computer that will be used to control the instrument.

6 Communicating with and testing the ISAR

The ISAR instrument is shipped with a basic diagnostic program called ISARTOOLS that can be used for ISAR system familiarisation and to test the instrument functionality. ISAR allows considerable flexibility for defining how the instrument will make measurements. This section of the manual explains how to:

1. Interact with the ISAR instrument using a terminal emulator;
2. Test the ISAR system

6.1 Using the ISAR for the first time

The ISAR requires connection to a personal computer running Microsoft Windows or LINUX operating system in order for the user to be able to interact with and/or modify the basic configuration of the instrument. The ISAR onboard computer is a stripped down Red Head Linux computer that supports SFTP and SSH communication. It can communicate with a host computer either through a serial port or via an Ethernet connection.

On initial power up the ISAR should automatically run the ISAR Operating Code (ISOC) software that is stored in the onboard flash disc. In addition, the LED configuration of ISAR can be used to obtain the status of the instrument on power up (see Figure 6-1 and Table 6-1 for more information).

ⓘ The ISAR has a small panel of light emitting diodes (LED) to indicate the operational status of the instrument shown in Figure 6-1.

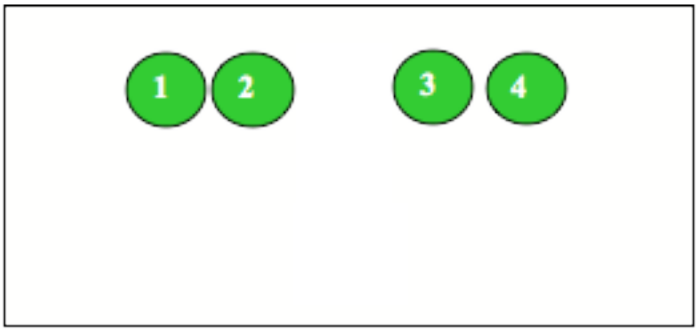


Figure 6-1 ISAR-5D status lights layout

Figure 6-1 shows the layout of the LED status lights whilst Table 6-1 (below) describes their function.

The LEDs will normally be orange if both possibilities are switched on except during the boot procedure when LED 1 alone will be orange as the instrument boots from the ISOC software.

Table 6-1 ISAR-5 status lights function

LED	Colour	Description
1	Green	**Indicates that the ISOC is running.**
1	Red	**Indicates an error.**
2	Green	**BB2 heater on/off (lit/unlit)**
2	Red	**BB1 heater on/off (lit/unlit)**
3	Green	**KT15 power on/off (lit/unlit)**
3	Red	**Spare power on/off (lit/unlit)**
4	Green	**Scan motor moving**
4	Red	**Shutter motor moving**

6.2 The ISAR diagnostics software (ISARTOOLS)

ISAR-5D ships with a generic diagnostic program called ISARTOOLS. This can be used to help familiarize the user with the instrument and to assist in diagnosing any problems. A copy of this program can be found in the \bin subdirectory of the ISAR-5D CD-ROM.

ⓘ A copy of the ISARTOOLS executable code is also available on the ISAR onboard flash disc (/home/isar/software). It is assumed that the user is able to use basic Linux commands.

6.3 Testing the ISAR instrument

Once the ISAR instrument is switched on, the ISOC software will boot and run the instrument as specified in the isarconf.cfg file on the SD card. In order to run the ISARTOOLS program, the ISOC has to be stopped by either pressing Y during the startup (before the ISOC reads the isarconf.cfg file) or by pressing Q after the startup routine has finished. Table 6-2 describes the command set of the ISARTOOLS program.

Table 6-2 Command set for the ISARTOOLS

Key	Description	Expected result
a	A-D converter single channel voltage	Requires channel number input (0-31). Outputs channel voltage
A	A-D converter all channels voltages	All 32 channel voltage readings
c	Open and close shutter *n* times	Requires *n* input. Shutter motor opens shutter *n* times
d	Closes the ISAR-5C shutter	Closes the shutter
D	Opens the ISAR-5C shutter	Opens the shutter
e	Reads the position of the scan drum	Prints scan drum angular position (degrees) with reference to the set zero position (see F)
E	Move the scan drum to a given angular position	Moves the scan drum to the angular position (degrees) you provide with reference to the set zero position (see F)
g	Read data from the GPS unit	Prints raw data read from the GPS unit (See section 8)
k	Send a command to the KT15.85D	Prints a reply string from the KT15 (See KT15 manual for more information)
K	Send KT15 configuration to KT15.85D unit	
L	Switches faceplate LEDs on/off	Requires LED number input. Selected LED switches on or off.
o	Config PNI	PNI will be configured
p	Reads data from the PNI compass module	Prints data to the screen (See section 8)
P	Sends a command to the PNI compass module	See the PNI TCM-2 manual for more information. Used to set up the PNI TCM-2 module prior to use in ISAR)
q	Exit the ISARTOOLS program	Returns to main menu
r	RS485 command	
R	Runs RS485 as defined in configuration file	
s	Scan test	Scans BB and outputs results to SD flash card
S	Scan test	Default scan of hot BB and outputs results to SD flash card
T	Reading temperatures	Output BB & thermistor temperatures to screen
v	Toggle thermistor reference voltage on & off	

Key	Description	Expected result
V	Read all supply voltages	

Once ISARTOOLS has been started, the user should be presented with a menu of options. A command is executed by typing a letter (case sensitive). Some commands have additional requirements and the user will be prompted by the program to enter appropriate data (refer to the command menu in Table 6-2 above for a summary of the available command set). The user will be returned to the menu screen after the execution of any command

The ISARTOOLS program can be used to test the ISAR-5D instrument to ensure that no damage has occurred during transportation. The following tests should be executed:

- Check that the LEDs function (command L).
- Check that the shutter opens and closes (commands d and D). Check that the shutter opens completely and closes completely and that excessive current is not drawn during this operation (check the ampere meter on the power supply). Shutter movement should be smooth and the motors should maintain a steady speed.
- Check that the scan drum rotates and meaningful shaft encoder data is reported. This is best achieved by using the software to set the scan drum to point at an angle of 4.5°. Once the scan drum is in this position, the edge of the viewing aperture hole should line up exactly with the back face of the ISAR-5D body.
- Check that the KT15 reports meaningful data (typical values of ~ 0.5 V at room temperature when set to use a range of –100ºC to 100ºC would be expected)
- Check the black body heater circuits by first switching each BB heater off and collecting some data. Then turn each BB heater back on again and collect data (you may have to wait a few minutes for the BB's to warm up a little).
- Check the rain sensor. Moving your fingers in front of the sensor should be sufficient to generate a test signal.
- Check the PNI sensor by moving the ISAR instrument into different angular positions in both the vertical and horizontal plane.
- Check the GPS unit. Note that you will need to have the antenna connected and located in a position where GPS satellites can be seen to obtain meaningful data.

ⓘ Should any test fail please contact the ISAR team immediately.

Once you have successfully completed all the diagnostic tests, the ISAR-5D is ready to use.

7 Using the ISOC operational data logging software

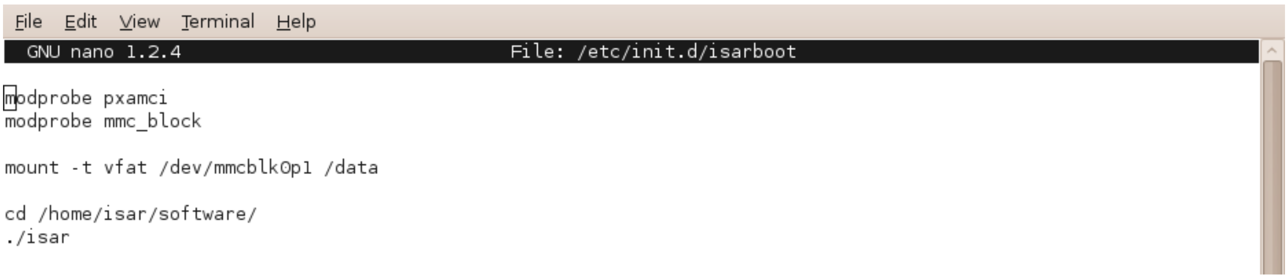
ISAR is designed to allow considerable flexibility in defining how the instrument will make measurements for an operational deployment. This is achieved through the ISAR *O*perating *S*ystem (ISOC). This section of the user manual explains how to:

1. Mount the ISAR SD card
2. Access the ISAR SD card using Linux commands
3. Upload a new ISOC executable program to the onboard computer
4. Configure the ISOC software to make user defined measurements

The root username and password are supplied on the accompanying ISAR CD-ROM and can also be found in the FAQ section of this manual.

7.1 Mounting the SD card

The onboard SD card can be mounted using a normal Linux prompt as follows:



7.2 Accessing the ISAR SD card

The ISAR system has an internal 2GB SD card that can be used to store programs, configuration files, calibration information and data files. The SD card can be accessed using standard Linux commands. The standard mount point is /data. File editing can be achieved using a suitable file-editing programme such as Nano.

7.3 Uploading a new program onto the ISAR instrument

Before any program can be executed, the program must be uploaded into the appropriate directory of the onboard computer *(/home/isar/software*) using standard Linux commands.

7.3.1 Loading a new operational code or configuration file onto ISAR

To load a program onto the ISAR the user can SFTP into the instrument using the instrument IP address and upload the required file, using standard Linux commands, to the */home/isar/software* directory.

7.3.2 Stopping the ISAR resident data logging program

When the ISAR is powered up, the ISOC data logging program will automatically run. The initial factory configuration of the ISOC code will make a SSTskin temperature measurement using a target view angle of 45º from nadir for the sea, 45º from zenith for the sky, using a sea water emissivity of 0.98. However, for most deployments this configuration is not optimal and needs to be changed before acquiring data for scientific purposes.

Pressing **Q** will stop the ISOC data logging software and return to the main menu. If for any reason this fails, the user can logon to the instrument (see accompanying ISAR CD-ROM or FAQ section for username and password). Using the standard Linux command (ps –ax), discover the appropriate ISAR program ID (PID) and use the 'kill -9 {PID}' command to stop the program.

7.4 Configuration of ISAR: Using the isarconf.cfg file

The ISAR operational software, ISOC, has been written to provide a versatile and easily configurable data logging software interface.

The isarconf.cfg file is the instrument configuration file that is read by the ISAR system every time the data logging program (ISOC) is started. The configuration file is stored in the */home/isar/software/* directory and is a specific format ASCII text file. It contains instrument specific calibration data, component identifications and user configuration fields. The general format of the isarconf.cfg file is for a comment line, denoted by #### at the start of the line, followed by a data line. For example:

```
#### Title for this deployment/configuration stating purpose of this isarconf file
(str[255])
TITLE=icf file for ISAR-06 valid for isar linux -v2.0.0 code base
```

ⓘ A complete isarconf.cfg file is provided as a reference in Appendix A.

In general, the comment line provides the format of the following data line. In practice, only a few isarconf.cfg fields need to be changed by the user and these are discussed by task in the following sub-sections.

Modifying any of the calibration data entries within the isarconf.cfg file may result in either your ISAR refusing to boot or incorrect results. ALWAYS make a backup copy of the current isarconf.cfg file.

The fields that require user editing are provided at the start of the isarconf.cfg file. Most entries should not be changed unless the user is absolutely certain that they know what is required and that they understand the implications that any changes will have on the ISOC data logging system and subsequent measurements. In general it should only be necessary to set up the header sections, scan drum and associated sampling characteristics, the real time SST calculation configuration and any external RS485 devices that may have connected to the ISAR instrument.

The following isarconf.cfg entries should be used as examples of how to describe the purpose of the isarconf.cfg file:

```
#### Title for this deployment/configuration stating purpose of this isarconf file (str[255])
TITLE=icf file for ISAR-06 valid for isar linux -v2.0.0 code base
#### ICF author name, e-mail and telephone number (str[255])
AUTHOR=W Wimmer
EMAIL=w.wimmer@soton.ac.uk
PHONE=+44 (0)2380 597654
#### Last Edit date of this icf file yyyy-mm-dd (str[15])
EDITDATE=2011-06-08
#
LOGFILE_PATH=/data/
```

7.4.1 Configuration of KT15.85D parameters

The KT15.85D may be configured to operate in a variety of different modes. The isarconf.cfg file allows a user to define the serial number of the KT15 unit, calibration information, emissivity settings, response times and communication parameters. The following settings provide a default configuration for a KT15 radiometer (these particular values are specific to instrument serial number 10200):

```
#### KT15.85D Serial number (int)
KT15_SN=10200
#### Date and details of KT15.85D last calibration (str[255])
KT15_CAL=2007-05-11, Polynomials for R2T & T2R: TJ Nightingale 2003-06-04
#### KT15 emissivity setting command (0.001 -> 1.000) (str[15])
KT15_CMD_EMISIVITY=EPS 1.000
#### KT15 response setting command (0.05, 0.1, 0.3, 1 3 or 10 seconds) (str[15])
KT_CMD_RESP=RESP 1.0
#### KT15 analog output setting command (Do you know what you are doing ?) (str[30])
KT15_CMD_ANALOG=ANALOG -100.0 50.0 C 3
#### KT15 serial interface setting (Do you know what you are doing ?) (str[20])
KT_CMD_SERIAL=COM 96 8 1 n
#### KT15 Temperature to Radiance coefficients based on kt15 filter response (-1 not used) (double[9])
KT15_COEFF_T2R=-22.925646e0,  65.196703e0, -81.215855e0,  56.792568e0, -21.105313e0,  3.2575460e0,-1.0,-1.0,-1.0
#### Radiance to Temperature coefficients based on kt15 filter response (-1 not used) (double[9])
KT15_COEFF_R2T=273.15973e0,54.529628e0,10.634341e0,2.0172007e0,3.6480705e-1,5.7776974e-2,6.5293295e-3,3.5814663e-4,-1.0
```

Notes:

1. The KT15 serial number is **unique** to each unit. It is entered into the isarconf.cfg file in order that a cross check may be made between the KT15 serial number from the actual unit and that in the isarconf.cfg entry. This helps to avoid applying the calibration data for one KT15 unit to another KT15 when more than one unit is available.
2. The KT15 calibration date refers to the last calibration of the KT15 unit by Heitronics and refers to the Radiance to Temperature and Temperature to Radiance coefficients.
3. The KT15 emissivity value should always be set to 1.0
4. The KT15 default response time is 1.0s
5. The analogue parameters should not be modified
6. The Serial interface parameters should not be modified
7. The Radiance to Temperature and Temperature to Radiance data should not be modified. These are specific to each KT15 unit and are calculated from the calibration data provided by Heitronics.

7.4.2 Setting the ScanDrum park angle

The scan drum park angle refers to the default angle at which the scan drum will be placed when the ISAR shutter is closed. It is set using the following line of the isarconf.cfg file:

```
#### A2 encoder park angle (normally over lower blackbody) (float,deg)
ENCODER_PARK=280.0
```

Notes:

1. The park angle is an absolute rotational position with a zero position dependent on the ISAR-5D shaft encoder reference position. Normally, 0 is vertically up, 180 is vertically down. The shaft encoder must be configured appropriately.
2. The default position sets the scan aperture to view the lower BB. Parking the scan drum in this position prevents water ingress.

7.4.3 Setting the shutter open delay following a rain event

Following a rain event, a delay period is required (a) to allow rainwater to drain away from the ISAR and (b) to be sure that the rain event has actually stopped. The delay is entered as *n* cycles where the delay time is approximately calculated as *n**2 seconds. A recommended choice of delay is *n* ~350. If you are working with the ISAR in the laboratory for a calibration, then a rain event delay is not required. Use the following line of the isarconf.cfg to reduce the shutter open delay following a rain event:


```
#### Number of cycles (n) to wait after rain event has finished (time is ~n*2 secs.  Lab=60 Field= ~350)
(int)
ORG_OPEN_DELAY=350
```

7.4.4 Setting the Optical Rain Gauge shutter trigger threshold

The Optical Rain Gauge (ORG) is used to trigger the ISAR shutter mechanism and close the instrument down if rain or sea spray is detected. The ORG has a background noise level above which a rain/spray event becomes significant. This is set using an ORG voltage threshold using the following isarconf.cfg line:

```
##### Optical rain gauge rain voltage threshold below which shutter is closed (float). Field~1.1
ORG_MEAN_LIMIT=1.1
```

During long deployments some surface contamination of the ORG optical system may occur and the voltage threshold value should be set with some margin of tolerance to allow for this. However, this may result in an increased possibility of ISAR not closing down quickly enough once a rain/spray event has been detected. Typically, a rain event is characterized by a significant increase in the standard deviation of the signal and therefore a second threshold can be set to trigger the ISAR shutter, based on the standard deviation of the ORG signal. This second check is determined by calculating the standard deviation of 25 ORG measurements and comparing this against a threshold value. The following lines of the isarconf.cfg file may be used for this purpose:

```
#### Optical rain gauge rain voltage standard deviation above which shutter is closed (float).Lab =5,
Field= 1.2
ORG_SD_LIMIT=5
```

Notes:

1. The voltage mean threshold should be verified by basic tests before any unattended deployments at sea. A value of 1.0-1.2 is typical.
2. The current signal is within the range 4 mA- 20 mA and passes through a 220Ω resistor so that 880 mV represents no rain.

7.4.5 Setting the Shaft Encoder Reference position

The shaft encoder reference position must be set to allow the ISAR scan drum to position itself correctly. A simple method to check the configuration is to use the Prot software to carefully position the rear edge of the scan drum aperture flush against the back wall of the ISAR body so that it is looking vertically up and along the central cutaway. The scan drum position should read 355.5° in this position. If this is not the case, an appropriate offset from zero may be set using the following isarconf.cfg line:

```
#### A2 encoder reference position (float,deg)
ENCODER_REF=0.0
```

Notes:

1. If the Scan drum positions are inconsistent it may mean that the shaft encoder has lost its internal configuration. This can be reset using the encoder setup software provided on the software CDROM.
2. Ensure that the scan drum aperture is lined up as accurately as possible using this method.

7.4.6 Setting the heated black body

Both ISAR black body (BB) units are identical and both have a Kapton heater that can be used to heat the BB cavity. In normal operation, one of the BB units is heated to above ambient temperature whilst the other is allowed to remain at roughly ambient temperature. Normally, the upper (325°) BB unit (BB2) should be selected as the heated BB since this points downward, preventing heat loss from the cavity by air advection when the scan drum aperture opens. The following line of the isarconf.cfg must be used to configure the BB heater system:

```
#### Heated (Active) blackbody (1 or 2; Normally 2 unless changed by user)
HOTBB=2
```

7.4.7 Logging data to the ISAR SD card

The ISAR system has a 2GB SD card system that can be used to store ISAR average and SST data records. All data are appended to a file called ISARDATA.DAT. Data logging to the SD card can be turned ON by the following line in the isarconf.cfg file:

```
LOG_DATA=1
```

7.4.8 Configuring ISAR measurement angles

The ISAR can be configured to obtain data from a target at any angular position (0-360º) by setting the scan drum angle to a given angular location. Experience has shown that 10 positions are sufficient for most applications. The isarconf.cfg file can be used to specify 10 "set" scan drum positions by using the following line:

```
SCAN_POS_1=280.0,30
SCAN_POS_2=325.0,30
SCAN_POS_3=25.0,10
SCAN_POS_4=155.0,40
```

In this example, four target views will be sampled sequentially in the order from top to bottom (280, 325, 25 and 155 degrees).

💣 Note that views of the ISAR calibration blackbody targets (280.0º and 325.0º) must be defined as view angles here. Otherwise the ISAR will not function properly.

Note that both the view angle and the number of samples to be viewed at that angle must be specified explicitly for each position so that in the example given here, 30 samples will be made at angles 280º, and 325º, 40 samples at 155º but only 10 samples will be made at angle 25º.

Notes:

1. It is possible to set a complex measurement sequence of alternate BB and target views using this method.
2. Angular positions are accurate to approximately 0.1 degree

7.4.9 Requesting ISAR to provide a real time SSTskin data record

The ISAR can also compute a real time SSTskin data record. This can be selected using the following line of the isarconf.cfg file:

```
CALC_SST=1
```

In order for a SSTskin temperature to be properly derived from raw ISAR measurements, the isarconf.cfg file must also specify which of the scan positions corresponds to the view of sea radiance and which corresponds to the view of sky radiance. This is done by setting the variable **SEAVIEW_POS** which depends on the rank order of the sea view in the list of **SCAN_POS_*n*** definitions, as described in section 7.4.8, and similarly setting the variable **SKYVIEW_POS** based on the rank of the sky view definition. Please note that in this version of the operating software, the list of positions counts from zero and so the user should enter the value (*n* - 1) when referring to SCAN_POS_*n*.

Thus in the example below, following the example scan position settings used in Section 7.4.8, the target sea view corresponds to SCAN_POS_4 = 155, and so SEAVIEW_POS is set to 3. The sky view corresponds to SCAN_POS_3 = 25.0 and so SKYVIEW_POS is set to 2.
The SSTskin calculation must also use an appropriate seawater emissivity value for a given deployment geometry. In the example an emissivity value of 0.991635 has been used for the emissivity of seawater appropriate for the particular angle of view selected. Other variables in the SSTskin calculation can also be specified.

The following lines in the isarconf.cfg file show how this is achieved.

```
#### Defining variables that will be used to calculate SSTskin temperature;
# SEAVIEW_POS - seaview scandrum position; SKYVIEW_POS - skyview scandrum position; EMISSIVITY - seawater emissivity; RMR_CORR - RMR x correction factor;
# VREF - reference voltage (0 if using internal voltage); RREF – reference resistance;
#INTBB_EMISSIVITY - internal BB emissivity; SELFHEAT_CORR - self heating correction on/off
SEAVIEW_POS=3
SKYVIEW_POS=2
EMISSIVITY=0.991635
RMR_CORR=1.0
VREF=0.0
RREF=10000.0
INTBB_EMISSIVITY=0.9993
SELFHEAT_CORR=0
```

Finally, data logging to the SD card is turned ON as before, using the following line in the isarconf.cfg file:

```
LOG_DATA=1
```

Notes:

1 If the emissivity value is out of range (i.e., < 0 or > 1.0), ISAR will not boot.
2 Care should be taken to ensure that the SST real time setup is valid in each case otherwise the SSTskin temperature data will be incorrect.
3 A suitable number of samples (typically > 20) is recommended on each black body unit.
4 The ISAR shaft encoder reference angle must be correctly set to ensure that all target views are correct.
5 The ISAR must be deployed correctly with a known geometry **relative to the sea surface** so that appropriate emissivity values are defined for the intended viewing angle of the sea surface. This may be verified using the PNI roll values.

7.4.10 Requesting ISAR to provide diagnostic data at boot

A summary of ISAR data outputs can be requested at the startup of the ISOC program. This can be used to check the functionality of the ISAR system and isarconf.cfg file. The following line in the isarconf.cfg file sets this function:

```
START_DIAGN=1
```

7.4.11 Requesting ISAR to log raw GPS data

The raw output from the ISAR on-board GPS system can be incorporated onto the ISAR data stream by the following line in the isarconf.cfg file:

```
RAW_GPS=1
```

The GPS data string provided by the GPS unit will appear as $GPGGA or $GPRMC data records (see section 8.5).

7.4.12 Requesting ISAR to log raw PNI TCM-2 compass data

The raw output from the ISAR on-board compass system can be incorporated into the ISAR data stream by the following line in the isarconf.cfg file:

```
RAW_PNI=1
```

The PNI data string provided by the PNI unit will appear as $PNIST data records (see section 8.7 below).

7.4.13 Requesting ISAR to print a $IS5MR record to the standard output

The user can request that the $IS5MR data record (stored on the internal SD card) is also outputted to RS232 by the following line in the isarconf.cfg file:

```
MEAN_REC=1
```

7.4.14 Requesting ISAR to print a $I5CAL record to the standard output

The user can request that the $I5CAL data record (stored on the internal SD card) is also outputted to R232 by the following line in the isarconf.cfg file:

```
CAL_REC=1
```

7.4.15 Requesting ISAR to run the BB crossing temperature routine

The user can request that the ISAR instrument runs a BB crossing temperature routine in a rain event. To avoid triggering the BB crossing routine in light showers, the threshold output from the ORG required to trigger the routine is set to ~2V (This value is fixed and cannot be changed in the configuration file). The following line in the isarconf.cfg file can switch on the BB crossing event:

```
XTEMP=1
```

7.4.16 Requesting ISAR to shut down when roll or pitch limits are exceeded

The user can request that the ISAR instrument shuts down when the preset roll or pitch limit (see 7.3.19) is exceeded. The instrument follows the standard rain routine for the shutdown and will return to normal operation once the roll or pitch reduces below the limit and the rain event countdown has finished. The roll or pitch shutdown can be switched on by the following line in the isarconf.cfg file:

```
ROLL_PITCH_STOP=0
```

7.4.17 Requesting ISAR to shutdown for low temperatures

The user can request that that the ISAR instrument shuts down when the ambient temperature falls below freezing (273.15K). The instrument uses the standard rain routine for the shutdown and will return to normal operation once the ambient temperature rises above 273.15K and the rain event countdown has finished. The following line in the isarconf.cfg file using the following lines can switch on the low temperature shutdown:

```
FREEZING=1
```

7.4.18 Requesting ISAR to wait for the ORG to warm up

Using the following line in the isarconf.cfg file, the user can request that that the ISAR instrument wait for 30 measurement cycles for the ORG measured voltage to drop below the limit set in 7.3.4. If either the measured voltage drops below the set limit or the 30 measurement cycles have been completed, the warming up loop will stop and the measurement loop start.

```
ORG_WARMING=1
```

7.4.19 Changing PNI TCM-2 pitch and roll alarm limits

During deployment, if the ship exceeds defined pitch and roll limits, the ISAR system will flag the $ISAR5 data records accordingly using the 7th and 8th bits of the **StatusWord** (see section 8) The following lines of the isarconf.cfg file set these pitch and roll limits:

```
# PNI sensor pitch warning limit (deg) (float)
PITCH_LIMIT=2.0
# L23: PNI sensor roll warning limit  (deg) (float)
ROLL_LIMIT=2.0
```

Notes:

1. Pitch and roll limits are used to provide warnings only, reported via the **StatusWord** bits 7-8
2. If ROLL_PITCH_STOP (see 7.3.16) is set to 1, the instrument will shut down (ISAR behaves like it would in a rain event).

7.4.20 Using the ISAR RS485 sub-system

ISAR allows for the connection of RS485 devices to the main system and to log data from these devices directly into the ISAR data stream. The following parameters must be set in the isarconf.cfg file for each RS485 device:

(α) A label for the device
(β) The RS485 address
(χ) The device specific read command

Each RS485 device should be configured to an appropriate baud rate, with no stop bits and no parity. The following isarconf.cfg lines allow for RS485 configuration:

```
#### Up to 8 External RS485 devices can be sequentially defined.
# RS485_n_NAME - label for device; RS485_n_ADDRESS - RS485 address; RS485_n_COMMAND - device specific read command;

RS485_1_NAME=RhoPD_D1102_CM11_Solarimeter
RS485_1_ADDRESS=4
RS485_1_COMMAND=$4RD
```

In this example, a single RS485 device has been configured with the title **RhoPD_D1102_CM11Solarimeter**. It is located at address **4** and the data read command is 4RD.

Notes:

1. The present system assumes that a numeric data value is received, prefixed by an identifier character (* is the RhoPoint default return). Please contact the ISAR team for specific requests if this is not appropriate.

7.4.21 Configuration of ISAR basic measurements - summary

In order to record a basic set of radiance and SST measurements, the ISAR instrument needs to be configured appropriately. The ISOC data logging program collects data in measurement cycles, with each measurement cycle consisting of the following measurements:

- BB1 calibration data
- BB2 calibration data
- Target observations

Note that the ISOC program allows the user to select up to 10 programmable target scan drum positions that are specified as angles. ISAR-5D must first collect *n* measurements whilst viewing BB1, *n* measurements whilst viewing BB2 and then, for each target position, it will make *x* measurements before moving on to the next target position. Finally, *n* measurements whilst viewing BB1 and *n* measurements whilst viewing BB2 will be made to ensure that a meaningful calibration trend can be established over the measurement period. Each sample takes approximately 1 second to collect (without additional instruments attached to the RS485 port).

Use the following decision checklist to setup ISAR to make your measurements:

- What scan drum angles need to be set, including viewing the BBs?
- How many samples are required at each scan drum position?
- Should the data be logged to the internal SD card?
- Should an SSTskin measurement be made (if so setup the calculation)?
- Should GPS data be logged?
- Should PNI data be logged?

The ISOC data logging program will:

- Check and initialise each of the ISAR systems;
- Read the user defined configuration settings for this execution from the isarconf.cfg file stored on the ISAR SD card;
- Write the current instrument configuration in the data stream;
- Begin logging data.

8 ISAR data record format

The ISAR data stream is a formatted comma separated variable (csv) data record with an NMEA style ASCII string output. Several NMEA style identifiers are used to define the different ISAR5 data record types. These are defined in Table 8-1 below.

Table 8-1 ISAR-5 NMEA style data record identification labels

NMEA style identifier	Description
$ISMSG	A comment or message string
$ISAR5	A standard ISAR-5 data record
$IS5MN	An averaged ISAR-5 data record
$I5SST	A SSTskin data record for real time operations
$I5CAL	Calibration data used to compute real time SST measurement provided in $I5SST
$GPGGA	GPS fix data (NMEA version 2.1)
$GPRMC	GPS data: Recommended minimum Specific GPS/Transit data
$PNIST	TCM2 Electronic compass data record
$IDIAG	Diagnostics test outputs
$IS485	A data record containing external RS485 device outputs
$ISCFG	Configuration data and messages relating to the isarconf.cfg configuration file
$IWARN	A warning message for consideration
$ISHCG	Additional information beyond scope of $ISAR5
$DEBUG	Debug information
$ISERR	ISAR error message. Problem needs addressing.
$ISTAT	ISAR status message
$ISSCN	ISAR scan information
$IS5AD	A-D converter message

Each data record type is fully expanded in the following sections. Note that these records are valid for the ISOC v2.0 code base and above.

8.1 $ISMSG data records

$ISMSG strings will appear in the data file to provide an indication of warnings or general operational status of the instrument. The $ISMSG format is

$ISMSG,<timestring>,<message text>

<timestring> takes the standard ISO 8601 format for a single variable date + time and has the format

YYYYMMDDTHHMMSS

For example:

```
$ISMSG, 20110727T103046Z, Initialising DMM32 ..
$ISMSG, 20110727T103046Z, Setting DMM32 digital ports to zero
```

8.2 Standard data record format ($ISAR5)

$ISAR5 is a standard ISAR data record that is produced approximately every second by the ISAR system. Each sensor on board the ISAR is read and the data value stored in the lowest processed state. This constitutes the level-0 engineering data output. The format of an $ISAR5 record is fully described in Tables 8-2 and 8-3. If any external RS485 devices are attached to ISAR that are correctly configured in the isarconf.cfg file, a $IS485 data record will be produced to output the measurements made by each RS485 device. The format of a $IS485 record is shown in Table 8-4.

Table 8-2. Format of $ISAR5 data record (ISOC-v2.0)

CSV Position	Example	Units	Description	Format
0	$ISAR5		NMEA style identifier	String
1	20110727T103129Z	yymmddThhmmssZ	ISO 8601 time string YearMothDayTHourMinuteSecondZ	Integer
2	25.02	Degrees	Scan drum position	Float
3	0.0603	mV	Optical rain gauge signal	Float
4	0.7025	mV	KT15.85D signal	Float
5	1.7525	Counts	BB1 thermistor 3 (base)	Float
6	1.7386	Counts	BB1 thermistor 2 (base)	Float
7	1.7353	Counts	BB1 thermistor 1 (aperture)	Float
8	2.3296	Counts	BB2 thermistor 3 (base)	Float
9	2.3284	Counts	BB2 thermistor 2 (base)	Float
10	2.3295	Counts	BB2 thermistor 1 (aperture)	Float
11	2200	Counts	5 Volt reference voltage for BB thermistors (should be ~2200 +/- 100counts)	Integer
12	2000	Counts	BB Aperture thermistor 1	Integer
13	2300	Counts	BB aperture thermistor 2	Integer
14	1200	Counts	BB aperture thermistor 3	Integer
15	1900	Counts	KT15 external case thermistor	Integer
16	1977,	Counts	ZnSe window thermistor	Integer
17	2612	Counts	TT8 computer board thermistor	Integer
18	3795	Counts	Input power	Integer
19	0	0 or 1	Shutter switch 1	Integer (1 active)
20	1	0 or 1	Shutter switch 2	Integer (1 active)
21	-3.1000	Degrees	Pitch	Float
22	1.1000	Degrees	Roll	Float
23	181.70	Degrees	Azimuth	Float
24	22.5	Degrees	PNI board temperature	Float
25	50.893501	Degrees	Latitude	Float
26	-1.39583	Degrees	Longitude	Float
27	11.0	Knots	Speed over ground	Float
28	32.4	DegreesT	Course made good	Float
29	4.2	Degrees	Magnetic variation	Float
30	289.1	Kelvin	KT15 target temperature measurement	Float
31	290.2	Kelvin	KT15 internal reference temperature	Float
32	23634128	(see table 4.2 below)	Record status flags	Long
33	06/10200	ISARID/KT15ID	Serial number of ISAR instrument and serial number of KT15 instrument	Char

Table 8-3. Interpretation of the $ISAR5 data record status word bit field (ISOC-v2.0)

Bitfield position	Description if set
0	**Data collected in a rain event**
1	**GPS data are bad**
2	**PNI data are bad**
3	**TT8 clock reset from GPS**
4	**Rain detected by ORG**
5	**Shutter is Closed**
6	**Optical rain gauge data are bad**
7	**PNI roll limit exceeded**
8	**PNI pitch limit exceeded**
9	**RS485 data present in data record**
10	**Bad data from 18 bit A/D**
11	**Bad scan drum position**
12	**Not used**
13	**Not used**
14	**Not used**
15	**Not used**

Table 8-4. Format of a $IS485 data record (ISOC-v2.0). Note that at least 1 external RS485 device must be correctly configured in the isarconf.cfg file for a $IS485 record to be produced.

CSV Position	Example	Units	Description	Format
0	$IS485		NMEA style identifier	String
1	20030523T134544Z	yymmddThhmmssZ	ISO 8601 time string YearMothDayTHourMinuteSecondZ	Integer
2	Ch 0:*+2.33	Various	User defined RS485 device #0 outputs see bit 9 of Status flags	String
3	Ch 1:*+ 0.0045	Various	User defined RS485 device #1 outputs see bit 9 of Status flags	String
4	Ch 2:*+109.2	Various	User defined RS485 device #2 outputs see bit 9 of Status flags	String
5	Ch 3:*+10.3	Various	User defined RS485 device #3 outputs see bit 9 of Status flags	String
6	Ch 4:*+1000.2	Various	User defined RS485 device #4 outputs see bit 9 of Status flags	String
7	Ch 5:*+0.234523	Various	User defined RS485 device #5 outputs see bit 9 of Status flags	String
8	Ch 6:*+0.023415	Various	User defined RS485 device #6 outputs see bit 9 of Status flags	String
9	Ch 7:*+7.456432	Various	User defined RS485 device #7 outputs see bit 9 of Status flags	String
n	1/4382	ISARID/KT15ID	Serial number of ISARinstrument and serial number of KT15 instrument (e.g.,1/4832)	Char

Note that a $IS485 record will be terminated by the ISAR instrument ID field regardless of the number of outputs. For example if a single RS485 was connected to ISAR, the following output might be obtained:

```
$IS485,Ch 0:99.234,1/4832
```

However, if two external RS485 devices (one multi-channel and one single-channel) were connected the output would be obtained:

```
$IS485,Ch 0:*-99.234*+33.998,Ch 1:*+0.2333,1/4832
```

8.3 Averaged data record format ($IS5MN)

$IS5MN is an averaged ISAR data record. It consists of the mean value for a number of standard data records obtained for a given scan drum position. A new $IS5MN data record is created for each new scan drum position. The format of a $IS5MN record is fully described in Table 8-5. Users may request that $IS5MN data are stored to the ISAR-5D SD card data file by setting the appropriate user flag in the isarconf.cfg file stored on the ISAR-5D SD card (see section 7.3.13).

Note that a $IS5MN record will be terminated by the ISAR instrument ID field regardless of the number of outputs.

Table 8-5. Format of a $IS5MN data record (ISOC-v2.0)

CSV Position	Example	Units	Description	Value and format
0	$IS5MN		NMEA style identifier	String
1	20110727T103402Z	yyyyddmmThhmmssZ	ISO 8601 time string YearMothDayTHourMinuteSecondZ	Integer
2	25.02	Degrees	Scan drum position	Float
3	0.001	Degrees	Scan drum position Standard deviation	Float
4	30		Number of scan drum position measurements averaged	Float
5	0.0603	mV	Optical rain gauge signal	Float

CSV Position	Example	Units	Description	Value and format
6	0.001	Degrees	Standard deviation of optical rain gauge signal	Float
7	30		Number of optical rain gauge measurements averaged	Float
8	0.7025	mV	KT15.85D signal	Float
9	0.001	Degrees	Standard deviation of kt15 signal	Float
10	30		Number of kt15 signal measurements averaged	Float
11	1.7525	Counts	BB1 thermistor 3 (base)	Float
12	0.001	Degrees	Standard deviation of BB1 thermistor 3	Float
13	30		Number of BB! Thermistor 3 measurements averaged	Float
14	1.7386	Counts	BB1 thermistor 2 (base)	Float
15	0.001	Degrees	Standard deviation of BB1 thermistor 2	Float
16	30		Number of BB1 Thermistor 2 measurements averaged	Float
17	1.7353	Counts	BB1 thermistor 1 (aperture)	Float
18	0.001	Degrees	Standard deviation of BB1 thermistor 1	Float
19	30		Number of BB1 Thermistor 1 measurements averaged	Float
20	2.3296	Counts	BB2 thermistor 3 (base)	Float
21	0.001	Degrees	Standard deviation of BB2 thermistor 3	Float
22	30		Number of BB2 Thermistor 3 measurements averaged	Float
23	2.3284	Counts	BB2 thermistor 2 (base)	Float
24	0.001	Degrees	Standard deviation of BB2 thermistor 2	Float
25	30		Number of BB2 Thermistor 2 measurements averaged	Float
26	2.3295	Counts	BB2 thermistor 1 (aperture)	Float
27	0.001	Degrees	Standard deviation of BB2 thermistor 1	Float
28	30		Number of BB1 Thermistor 2 measurements averaged	Float
29	2200	Counts	5 Volt reference voltage for BB thermistors (should be ~2200 +/- 100counts)	Integer
30	0.001	Degrees	Standard deviation of 5V reference	Float
31	30		Number of 5V reference measurements averaged	Float
32	2000	Counts	BB aperture thermistor 1	Integer
33	0.001	Degrees	Standard deviation of BB aperture thermistor 1	Float
34	30		Number of BB aperture thermistor 1 measurements averaged	Float
35	2000	Counts	BB aperture thermistor 2	Integer
36	0.001	Degrees	Standard deviation of BB aperture thermistor 2	Float
37	30		Number of BB aperture thermistor 2 measurements averaged	Float
38	2000	Counts	BB aperture thermistor 3	Integer
39	0.001	Degrees	Standard deviation of BB aperture thermistor 3	Float
40	30		Number of BB aperture thermistor 3 measurements averaged	Float
41	2000	Counts	KT15 external body thermistor	Integer
42	0.001	Degrees	Standard deviation kt15 external body thermistor	Float
43	30		Number of kt15 external body measurements averaged	Float
44	1910,	Counts	ZnSe window thermistor	Integer
45	0.001	Degrees	Standard deviation of ZnSe thermistor	Float
46	30		Number of ZnSe thermistor measurements averaged	Float
47	2612	Counts	TT8 computer board thermistor	Integer
48	0.001	Degrees	Standard deviation of TT8 computer board thermistor	Float
49	30		Number of TT8 board thermistor measurements averaged	Float
50	3795	Counts	Input power	Integer
51	0.001	Degrees	Standard deviation of input power	Float
52	30		Number of input power measurements averaged	Float
53	0	0 or 1	Shutter switch 1	Integer (1 active)
54	1	0 or 1	Shutter switch 2	Integer (1 active)
57	-3.1000	Degrees	Pitch	Float
58	0.001	Degrees	Standard deviation of pitch measurement	Float

CSV Position	Example	Units	Description	Value and format
59	30		Number of pitch measurements averaged	Float
60	1.1000	Degrees	Roll	Float
61	0.001	Degrees	Standard deviation of roll measurements	Float
62	30		Number of roll measurements averaged	Float
63	181.70	Degrees	Azimuth	Float
64	0.001	Degrees	Standard deviation of azimuth measurements	Float
65	30		Number of azimuth measurements averaged	Float
66	22.5	Degrees	PNI board temperature	Float
67	0.001	Degrees	Standard deviation of PNI board temperature	Float
68	30		Number of PNI temperature measurements averaged	Float
69	50.893501	Degrees	Latitude	Float
70	-1.39583	Degrees	Longitude	Float
71	11.0	Knots	Speed over ground (SOG)	Float
72	0.001	Degrees	Standard deviation of SOG	Float
73	30		Number of SOG measurements averaged	Float
74	32.4	DegreesT	Course made good (CMG)	Float
75	0.001	Degrees	Standard deviation of CMG	Float
76	30		Number CMG of measurements averaged	Float
77	4.2	Degrees	Magnetic variation	Float
78	0.001	Degrees	Standard deviation of magnetic variation	Float
79	30		Number of magnetic variation measurements averaged	Float
80	289.9	Kelvin	KT15 Target temperature	Float
81	0.001	Kelvin	SD KT15 target temperature	Float
82	30		Number of KT15 target temperature measurements averaged	integer
83	290.9	Kelvin	KT15 internal reference temperature	Float
84	0.001	Kelvin	SD KT15 reference temperature	Float
85	30		Number of KT15 reference temperature measurements averaged	integer
86-112	Float	Various	8 optional user defined RS485 device outputs with SD and number of observations	
	0.001	Degrees	Standard deviation of RS485 measurement	Float
	30		Number of RS485 measurements averaged	Float
N	06/10200	ID/Serial	ISAR-5 instrument ID+kt15 serial	Integer

8.4 SSTskin data record format ($I5SST) and associated calibration data ($I5CAL) record format

Where a user has requested that ISAR-5D calculates the SSTskin in real time (by setting the appropriate user flag in the isarconf.cfg file), a $I5SST data record will be produced. In addition, a $I5CAL data record is also produced which contains the blackbody calibration data that has been used to compute the real time SSTskin measurement. A new $I5SST data record is created for each scan sequence when there are sufficient data available for a real time SSTskin calculation. Note that for the SSTskin calculation to be valid, the isarconf.cfg file must contain appropriate configuration information in the SST calculation section, including the scan drum angle index for both sea and sky views and the value to use for the emissivity of sea water (see section 7.3.9). The format of an $I5SST record is fully described in Table 8-6 and the format of a $I5CAL record is described in Table 8-7. Users may request that $I5SST data are stored to the ISAR-5 SD card data file by setting the appropriate user flag in the isarconf.cfg file stored on the ISAR-5D SD card.

Table 8-6. Format of a $I5SST data record (ISOC-v2.0)

CSV Position	Example	Units	Description	Value and format
0	$I5SST		NMEA style identifier	String
1	20110727T103707Z	yyyymmddThhmmssZ	ISO 8601 time string YearMothDayTHourMinuteSecondZ	Integer
2	299.78	Kelvin	Mean SSTskin	Float
3	155.0	Degrees	Mean Scan drum position for sea view data	Float

CSV Position	Example	Units	Description	Value and format
4	0.78	Counts	Mean KT15 signal for sea view	Float
5	0.023	Counts	Mean Standard deviation of sea view signal	Float
6	40		Number of valid $ISAR5 sea view data records used in calculation	Integer
7	25.0	Degrees	Mean Scan drum position for sky view data	Float
8	0.38	Counts	Mean KT15 signal for sky view	Float
9	0.235	Counts	Mean Standard deviation of sky view signal	Float
10	10		Number of valid $ISAR5 sky view data records used in calculation	Integer
11	-3.1000	Degrees	Mean Pitch for sea view segment	Float
12	0.0233	Degrees	Standard deviation of Pitch for sea view segment	Float
13	1.1000	Degrees	Mean Roll for sea view segment	Float
14	0.0233	Degrees	Standard deviation of Roll for sea view segment	Float
15	50.893501	Degrees	Mean Latitude for sea view segment	Float
16	-1.39583	Degrees	Mean Longitude for sea view segment	Float
17	11.0	Knots	Mean Speed over ground for sea view segment	Float
18	32.4	DegreesT	Mean Course made good for sea view segment	Float
19	4.2	Degrees	Mean Magnetic variation for sea view segment	Float
20	2234	counts	Mean 5V BB reference voltage	Integer
21	2234	counts	Mean Electronics board thermistor	Integer
22	2343	counts	Mean input power supply	Integer
23	0.98588		Emissivity value used in temperature calculation	Float
24	06/10200	ID/Serial	ISAR-5 instrument ID+kt15 serial	Integer

Table 8-7. Format of a $I5CAL data record (ISOC-v2.0)

CSV Position	Example	Units	Description	Value and format
0	$I5CAL		NMEA style identifier	String
1	20110727T103402Z	yyymmddThhmmssZ	ISO 8601 time string YearMothDayTHourMinuteSecondZ for Calibration data on BB1	Integer
2	280.0	Degrees	Mean Scan drum position for BB1 data	Float
3	0.001	Degrees	Mean Standard deviation of BB1 scan drum position	Float
4	2.459	Counts	Mean BB1 Temperature (mean base thermistors)	Float
5	0.001	Counts	Mean Standard deviation of BB1 temperature	Float
6	30		Number of samples used to compute BB1 temperature	Integer
7	0.6837	Counts	Mean BB1 KT15 signal	Float
8	0.0001	Counts	Mean Standard deviation of BB1 signal	Float
9	30		Number of samples used to compute BB1 signal	Integer
10	20030523T134422Z	yyymmddThhmmssZ	ISO 8601 time string YearMothDayTHourMinuteSecondZ for Calibration data on BB2	Integer
11	325.0	Degrees	Mean Scan drum position for BB2 data	Float
12	0.001	Degrees	Mean Standard deviation of BB2 scan drum position	Float
13	2.179	Counts	Mean BB2 Temperature (mean base thermistors)	Float
14	0.001	Counts	Mean Standard deviation of BB2 temperature	Float
15	30		Number of samples used to compute BB2 temperature	Integer
16	0.7356	Counts	Mean BB2 KT15 signal	Float
17	0.0038	Counts	Mean Standard deviation of BB2 signal	Float
18	30		Number of samples used to compute BB2 signal	Integer
19	06/10200		Isar id/kt15 id	

8.5 GPS Fix data (NMEA version 2.1) format ($GPGGA)

$GPGGA represents the raw output from the on-board GPS receiver that is placed into the ISAR-5 data stream. The $GPSGGA data format is a csv data record, formatted according to the NMEA version 2.1 standard as shown in Table 8-8. The ISAR ID and KT15 ID are also appended to the end of the string.

Table 8-8. Format of a $GPGGA data record

CSV Position	Example	Units	Description	Value and format
0	$GPGGA		NMEA version 2.1 identifier	String
1	122233.2	UTC time	Hhmmss.s format	Float
2	50.233	Degrees	Latitude	Float
3	N	Hemisphere	N or S	Char
4	1.344	Degrees	Longitude	Float
5	E	Quadrant	E or W	Char
6	1	Flag	GPS QC indicator: 0=NoGPS, 1=GPS, 2=DGPS	Integer
7	4	Count	Number of satellites in use	Integer
8	2.1		Horizontal Dilution of Precision (HDOP)	Float
9	9.4	Meters	Antennae altitude	Float
10	M		Character indicating Antennae altitude is in Meters	Char
11	4.9	Meters	Geodal separation in Meters. Difference between WGS-84 earth ellipsoid and mean sea level	Float
12	M		Char indicating Geodal separation is in Meters	Char
13	5.7	Seconds	Age of differential GPS data. Time in seconds since the last Type 1 or 9 upgrade	Float
14	0001	ID	Differential reference station ID (0000 – 1023)	Integer
15	06/10200		Isar id/kt15 id	

Note that if insufficient data are available due to a lack of visible GPS satellites, no data will be shown and the output will consist of only commas in the csv format.

8.6 GPS recommended minimum specific GPS/transit data (NMEA version 2.1) format ($GPRMC)

$GPRMC represents the raw output from the on-board GPS receiver that is placed into the ISAR-5 data stream. The $GPRMC data format is a csv data record formatted according to the NMEA version 2.1 standard as shown in Table 8-9 The ISAR ID and KT15 ID are appended to the end of the string.

Table 8-9. Format of a $GPGGA data record

CSV Position	Example	Units	Description	Value and format
0	$GPRMC		NMEA version 2.1 identifier	String
1	122233.2	UTC time	Hhmmss.s format	Float
2	A	Character	Status: A=valid, V=navigation receiver warning	Char
3	50.345	Degrees	Latitude	Float
4	N	Hemisphere	N or S	Char
5	2.675	Degrees	Longitude	Float
6	E	Quadrant	E or W	Char
7	20.4	Knots	Speed over ground (SOG)	Float
8	234.7	Degrees T	Course made good	Float
9	030326	Date	Yymmdd	Integer
10	3.4	Degrees	Magnetic variation	Float
11	E	Quadrant	E or W	Char
12			Checksum	Integer
15	06/10200		Isar id/kt15 id	

Note that if insufficient data are available due to a lack of visible GPS satellites, no data will be shown and the output will consist of only commas in the csv format.

8.7 TCM2 Electronic compass record format ($PNIST)

$PNIST represents the raw output of the on-board Precision Navigation TCM2 electronic compass module that is placed onto the ISAR-5 data stream. The standard output data record provided by the ISAR instrument has the following format:

$PNIST,<timestring>, $C<compass>$P<pitch>$R<roll>$T<temperature>*<checksum>, <Inst ID>

For example:

$PNIST, 20110727T104018Z, $C237.8P-3.2R2.0T31.1*06,6/10200

The $PNIST ISAR data record data format is shown in Table 8-10.

Table 8-10. Format of a $PNIST data record

ID	Units	Description	Example
$PNIST		NMEA style identifier	$PNIST
C<compass>	Degrees	Compass heading	$C151.2
P<pitch>	Degrees	Pitch measurement	$P-1.0
R<roll>	Degrees	Roll measurement	$R-3.2
T<temperature>	Celsius	Temperature of Electronics (0.5C precision)	$T27.5
06/10200	ID/Serial	ISAR-5 instrument ID+kt15 serial	Integer

8.8 Diagnostic data record format ($IDIAG)

ISAR diagnostic data that are collected when the ISAR instrument is booted are prefixed by the $IDIAG NMEA style identifier. The data are not used for any purpose other than to identify them as diagnostic data during the instrument start up process. If a $IDIAG output is requested (see section 7.3.10), diagnostic data are written to the standard output and a delay of 10s is provided to allow for the user to quit the deployment if required. The $IDIAG format is

$IDIAG,<timestring>,<message text>

<timestring> takes the standard ISO 8601 format for a single variable date + time and has the format

YYYYMMDDTHHMMSS

For example:

```
$IDIAG, 20110727T103101Z, Start of ISAR startup diagnostics ..
$IDIAG, 20110727T103101Z, Input supply:     22.39 V
$IDIAG, 20110727T103101Z, 5V supply:                4.98 V
```

8.9 ISAR Configuration data record format ($ISCFG)

$ISCFG strings will appear in the data file to provide configuration data and messages relating to the isarconf.cfg configuration file. The $ISCFG format is

$ISCFG,<timestring>,<message text>

<timestring> takes the standard ISO 8601 format for a single variable date + time and has the format

YYYYMMDDTHHMMSS

For example:

```
$ISCFG, 20110727T103124Z, KT15 Serial number: 10200
```


8.10 Warning message data record format ($IWARN)

$IWARN strings will appear in the data file to provide an indication of warnings related to the instrument. The $IWARN format is

$IWARN,<timestring>,<message text>

<timestring> takes the standard ISO 8601 format for a single variable date + time and has the format

YYYYMMDDTHHMMSS

For example:

`$IWARN, 20110727T103214Z, Serial port read Timeout!`

8.11 Additional high resolution current data record format ($ISHCG)

$ISHCG represents additional data regarding instrument voltages and currents. The $ISHCG data format is a csv data record formatted according to the NMEA version 2.1 standard as shown in Table 8-11 The ISAR ID and KT15 ID are appended to the end of the string.

Table 8-11. Format of a $ISHCG data record

CSV Position	Example	Units	Description	Value and format
0	$ISHCG		NMEA version 2.1 identifier	String
1	20110727T103159Z	UTC time	Hhmmss.s format	Float
2	3.3928	Volts	Input power	Float
3	3.3172	Volts	5V supply	Float
4	2.7934	Volts	12V supply	Float
5	3.5641	Volts	24V supply	Float
6	3.2945	Volts	Thermistor reference voltage	Float
7	1.0839	Volts	Current sensing BB2	Float
8	-0.0043	Volts	Current sensing BB1	Float
9	-0.0028	Volts	Current sensing 21 (not used)	Float
10	-0.0027	Volts	Current sensing 22 (not used)	Float
11	0.0064	Volts	Spare thermistor (not used)	Float
12	0.0152	Volts	Spare thermistor (not used)	Float
13	0.0141	Volts	Spare thermistor (not used)	Float
14	0.0005	Volts	Spare thermistor (not used)	Float
15	6/10200		Isar id/kt15 id	

8.12 Error message data record format ($ISERR)

$ISERR strings will appear in the data file to provide an indication of a fatal error that requires immediate action. The $ISERR format is

$ISERR,<timestring>,<message text>

<timestring> takes the standard ISO 8601 format for a single variable date + time and has the format

YYYYMMDDTHHMMSS

For example:

`$ISERR, 20110727T104011Z, (Warning) Bad input data to real-time SSTskin calculation`

8.13 ISAR scan message data record format ($ISSCN)

$ISSCN represents the raw information regarding the scan test that is executed from the ISARTOOLS menu. The $ISSCN data format is a csv data record formatted according to the NMEA version 2.1 standard as shown in Table 8-12.

Table 8-12. Format of a $ISSCNdata record

CSV Position	Example	Units	Description	Value and format
0	$ISSCN		NMEA version 2.1 identifier	String
1		Degrees	Scan drum position	Float
2		Voltage	KT15 voltage	Float
3		Voltage	24V supply	Float
4		Amps	Scan drum supply current	Float
5		Voltage	BB2 Thermistor 1 voltage	Float
6		Voltage	BB2 Thermistor 2 voltage	Float
7		Voltage	BB2 Thermistor 3 voltage	Float
8		Voltage	BB1 Thermistor 1 voltage	Float
9		Voltage	BB1 Thermistor 2 voltage	Float
10		Voltage	BB1 Thermistor 3 voltage	Float

9 Troubleshooting

Things can occasionally go wrong and here are several pointers to help you find out what the problem may be

9.1 Software

Check the isarconf.cfg file. This is normally the cause of most problems. See section 7.3.

9.2 ISAR FAQ

How do I close the ISAR shutter?

The ISAR shutter can be opened / closed via the ISARTOOLS software. The command for opening the shutter is **D** and for closing is **d**.

How can I upload / download a file?

SFTP into the instrument using the instrument IP address and upload or download the required file, using standard Linux commands, to or from the */home/isar/software* directory.

ⓘ Any excess lines (before the first # and after the last # should be deleted, however do not change the layout of the config file).

How do I set up the config file?

Use a text editor to edit the config file (e.g.: Nano for onboard instrument editing) and upload the new file to the instrument by SFTP'ing into the instrument using the instrument IP address and uploading the file, using standard Linux commands, to the */home/isar/software* directory.

Make sure the format of the config file is not changed. DO NOT delete or add any lines.

How can I download data from the ISAR?

SFTP into the instrument using the instrument IP address and download the required data, using standard Linux commands, from the */data* directory as set in the configuration file.

What software should I use to open/change the config file?

Any text editor that can read UNIX style text files (e.g.: Nano for onboard instrument editing)

What is the logon username and password?

User: root
Password: arcom

Appendix A: Example isarconf.cfg file (ISOC-v2.0)

The following provides an example isarconf.cfg configuration file as a guide. Note that entries shown in blue are user configurable. All other entries should not be changed unless you are sure of the implications and values.

```
#
######### ISAR configuration file for isar linux v2.x.x code base
######### General format: # comment followed by 1 line data (KEYWORD=DATA)
######### DO NOT DELETE ANY LINES FROM THIS FILE
#
#########
######### 2011-06-08: W Wimmer Version 2.0.0, Revision 1
#
################### Contact information #####################
#
#### Title for this deployment/configuration stating purpose of this isarconf file (str[255])
TITLE=icf file for ISAR-06 valid for isar linux -v2.0.0 code base
#### ICF author name, e-mail and telephone number (str[255])
AUTHOR=W Wimmer
EMAIL=w.wimmer@soton.ac.uk
PHONE=+44 (0)2380 597654
#### Last Edit date of this icf file yyyy-mm-dd (str[15])
EDITDATE=2011-07-26
#
LOGFILE_PATH=/data/
################### General instrument configuration ###############
#
#### ISAR-5D serial number (int)
ISARID=6
#### Date and details of last ISAR-5D instrument calibration date (str[255])
CALDATE=Pending (See ISAR-06-instrument-configuration.doc for history)
#### USER FLAGS: 1=condition set; 0=condition not set.
# LOG_DATA - log to flashcard; CALC_SST - compute SSTskin; START_DIAGN - diagnostic data at boot; RAW_PNI - output onboard compass data;
# RAW_GPS - output onboard GPS data; MEAN_REC - output $IS5MR data record; CAL_REC - output $I5CAL record; XTEMP - run BB crossing temperature routine;
# ROLL_PITCH_STOP - shutdown ISAR if roll or pitch limits exceeded; FREEZING - shutdown ISAR if ambient temp falls below 273.15K;
# ORG_WARMING - wait 30 measurement cycles before measurement loops starts
# For more details see manual section 7.x
LOG_DATA=1
CALC_SST=1
START_DIAGN=1
RAW_PNI=1
RAW_GPS=1
MEAN_REC=1
CAL_REC=1
XTEMP=0
ROLL_PITCH_STOP=0
FREEZING=0
ORG_WARMING=1
#### Number of cycles (n) to wait after rain event has finished (time is ~n*2 secs. Lab=60 Field= ~350) (int)
```

```
ORG_OPEN_DELAY=350
#### Number of scan samples when closed on BB1 & BB2
ORG_SCAN_SAMPLES=500
#### Configure ISAR measurement angles (angle in degrees, number of samples). Up to 10 positions can be sequentially set.
# Angles 280.0 & 325.0 must be set for BB on position 1 and 2.
SCAN_POS_1=280.0,30
SCAN_POS_2=325.0,30
SCAN_POS_3=25.0,10
SCAN_POS_4=90.0,40
#### Defining variables that will be used to calculate SSTskin temperature;
# SEAVIEW_POS - seaview scandrum position; SKYVIEW_POS - skyview scandrum position; EMISSIVITY - seawater emissivity; RMR_CORR - RMR x correction factor;
# VREF - reference voltage (0 if using internal voltage); RREF - reference resistance;
#INTBB_EMISSIVITY - internal BB emissivity; SELFHEAT_CORR - self heating correction on/off;
SEAVIEW_POS=3
SKYVIEW_POS=2
EMISSIVITY=0.991635
RMR_CORR=1.0
VREF=0.0
RREF=10000.0
INTBB_EMISIVITY=0.9993
SELFHEAT_CORR=0
#### Heated (Active) blackbody (1 or 2; Normally 2 unless changed by user)
HOTBB=2
#
################### External RS485 configuration ###############
#
#### Up to 8 External RS485 devices can be sequentially defined.
# RS485_n_NAME - label for device; RS485_n_ADDRESS - RS485 address; RS485_n_COMMAND - device specific read command;
#RS485_1_NAME=RhoPD_D1102_CM11_Solarimeter,
#RS485_1_ADDRESS=4
#RS485_1_COMMAND=$4RD
#
#RS485_2_NAME=RhoPD_D1102_PIR_Eppley
#RS485_2_ADDRESS=T
#RS485_2_COMMAND=$TRD
#
#RS485_3_NAME=RhoPD_D5132_PIR_Eppley
#RS485_3_ADDRESS=U
#RS485_3_COMMAND=$URB
#
#RS485_4_NAME=RhoPD_D5112_PAR
#RS485_4_ADDRESS=A
#RS485_4_COMMAND=$ARD
#
#RS485_5_NAME=AD_Converter
#RS485_5_ADDRESS=01
#RS485_5_COMMAND=#01
################### PNI compass configuration ###############
#
#### PNI sensor pitch warning limit (deg) (float)
PITCH_LIMIT=2.0
```

```
#### PNI sensor roll warning limit  (deg) (float)
ROLL_LIMIT=2.0
#### PNI compass serial number (str[80])
PNI_SN=9824_(v2.82)
#
################### ORG configuration ###############
#
#### Optical rain gauge serial number (str[80])
ORG_SN=0508501
#### SCTI Optical rain gauge description (str[128])
ORG_MODEL=Thies 5.4103.20.041
#### Optical rain gauge rain voltage threshold below which shutter is closed (float). Lab=1.0, Field= ~0.054
ORG_MEAN_LIMIT=5.1
#### Optical rain gauge rain voltage standard deviation above which shutter is closed (float). Lab=1.0, Field= ~0.002
ORG_SD_LIMIT=0.25
#### ORG history (str[128])
ORG_COMMENT=new model
#
################### A2 Encoder configuration ###############
#
#### US-DIGITAL A2 Encoder serial number (str[80])
ENCODER_SN=21363
#### A2 encoder reference position (float,deg)
ENCODER_REF=0.0
#### A2 encoder park angle (normally over lower blackbody) (float,deg)
ENCODER_PARK=280.0
ENCODER_BAUD=9600
ENCODER_RESOLUTION=14400
#
################### Optical component configuration ###############
#
#### ISAR-5D mirror serial number (str[80])
MIRROR_SN=OFR-MR-25-13 (2011-05-30)
#### ISAR-5D window serial number (str[80])
WINDOW_SN=CRYSRTAN-ZNSE bbar batch 24827 (2011-07-22)
#
########################### Motor configuration ###################
#
#### ISAR-5D scan drum drive motor and gearbox serial number (str[80])
SCAN_MOTOR=MAXON-A-Max 110926 Installed on: 2011-04-21
#### ISAR-5D shutter drive motor and gearbox serial number (str[80])
SHUTTER_MOTOR=MAXON-A-Max 110926 Installed on: 2011-04-21
########################### GPS configuration ###################
#
#### Trimble GPS board serial number (str[80])
GPS_SN=85843798 (Lassen SK8)
GPS_BAUD=4800
#
########################### KT15 configuration DO NOT ALTER !!###################
#
#### KT15.85D Serial number (int)
KT15_SN=10200
```

Date and details of KT15.85D last calibration (str[255])
KT15_CAL=2010-27-11, Polynomials for R2T & T2R: TJ Nightingale
KT15 emissivity setting command (0.001 -> 1.000) (str[15])
KT15_CMD_EMISIVITY=EPS 1.000
KT15 response setting command (0.05, 0.1, 0.3, 1 3 or 10 seconds) (str[15])
KT15_CMD_RESP=RESP 1.0
KT15 analog output setting command (DO NOT ALTER WITHOUT CONSIDERATION TO CONSEQUENCES) (str[30])
KT15_CMD_ANALOG=ANALOG -100.0 50.0 C 3
KT15 serial interface setting (DO NOT ALTER WITHOUT CONSIDERATION TO CONSEQUENCES) (str[20])
KT15_CMD_SERIAL=COM 96 8 1 n
KT15 Temperature to Radiance coefficients based on kt15 filter response (-1 not used) (double[9])
KT15_COEFF_T2R=-22.925646e0,65.196703e0,-81.215855e0,56.792568e0,-21.105313e0,3.2575460e0,-1.0,-1.0,-1.0
Radiance to Temperature coefficients based on kt15 filter response (-1 not used) (double[9])
KT15_COEFF_R2T=273.15973e0,54.529628e0,10.634341e0,2.0172007e0,3.6480705e-1,5.7776974e-2,6.5293295e-3,3.5814663e-4,-1.0
#
########################## Electronics configuration DO NOT ALTER!!###################
CPU BOARD
CPU_BOARD_DESC=ARCOM TITAN
CPU_BOARD_SN=2
COM BOARD
COM_BOARD_DESC=DIAMOND SYSTEMS EMM
COM_BOARD_SN=2
AD BOARD
AD_BOARD_DESC=DIAMOND SYSTEM DMM
AD_BOARD_SN=2
POWER BOARD
POWER_BOARD_DESC=NOCS
POWER_BOARD_SN=P2-RevB
THERM BOARD
THERM_BOARD_DESC=NOCS
THERM_BOARD_SN=T2-RevB
Serial number of CFCard (char[10]) e.g., SOC001
FLASHCARD=NOC005F
#
########################## Black body #1 configuration ###################
#
BB1 serial number (int)
BB1_SN=11
BB1 description (str[128])
BB1_DESC=See ISAR-BB-Configuration.doc for history
BB1 thermistor 1 serial number (str[80])
BB1_THERM1_SN=ISAR-TH10-11032
BB1 Thermistor 1 description (str[128])
BB1_THERM1_DESC=YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration
BB1 Thermistor 1 calibration coefficients: Range 268.16 ->338.16K, -1.0 not used(double[10])
BB1_THERM1_COEFF=1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
BB1 thermistor 2 serial number (str[80])
BB1_THERM2_SN=ISAR-TH11-11032

```
#### BB1 Thermistor 2 description (str[128])
BB1_THERM2_DESC=YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration
#### BB1 Thermistor 2 calibration coefficients: Range 268.16 ->338.16K, -1.0 not used(double[10])
BB1_THERM2_COEFF=1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### BB1 thermistor 3 serial number (str[80])
BB1_THERM3_SN=ISAR-TH12-11032
#### BB1 Thermistor 3 description (str[128])
BB1_THERM3_DESC=YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration
#### BB1 Thermistor 3 calibration coefficients: Range 268.16 ->338.16K, -1.0 not used(double[10])
BB1_THERM3_COEFF=1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#
########################## Black body #2 configuration ###################
#
#### BB2 serial number (int)
BB2_SN=12
#### BB2 description (str[128])
BB2_DESC=See ISAR-BB-Configuration.doc for history
#### BB2 thermistor 1 seriall number (str[80])
BB2_THERM1_SN=ISAR-TH04-11032
#### BB2 Thermistor 1 description (str[128])
BB2_THERM1_DESC=YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration
#### BB2 Thermistor 1 calibration coefficients: Range 268.16 ->338.16K, -1.0 not used(double[10])
BB2_THERM1_COEFF=1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### BB2 thermistor 2 serial number (str[80])
BB2_THERM2_SN=ISAR-TH05-11032
#### BB2 Thermistor 2 description (str[128])
BB2_THERM2_DESC=YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration
#### BB2 Thermistor 2 calibration coefficients: Range 268.16 ->338.16K, -1.0 not used(double[10])
BB2_THERM2_COEFF=1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### BB2 thermistor 3 serial number (str[80])
BB2_THERM3_SN=ISAR-TH06-11032
#### BB2 Thermistor 3 description (str[128])
BB2_THERM3_DESC=YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration
#### BB2 Thermistor 3 calibration coefficients Range 268.16 ->338.16K, -1.0 not used(double[10])
BB2_THERM3_COEFF=1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#
########################## Instrument Thermistor configuration ##################
#
#### Window thermistor serial number (str[80])
WINDOW_THERM_SN=Not configured
#### Window thermistor description (str[128])
WINDOW_THERM_DESC=Window; YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration
#### Window thermistor calibration coefficients: Range 268.16 ->338.16K, -1.0 not used(double[10])
WINDOW_THERM_COEF=1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### Channel A thermistor serial number (str[80])
THERM_A_SN=LOT:04A0423
#### Channel A thermistor description (str[128])
```

```
THERM_A_DESC=Channel A; YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration
#### Channel A thermistor calibration coefficients: Range 268.16 ->338.16K, -1.0 not used(double[10])
THERM_A_COEF=1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### Channel B thermistor serial number (str[80])
THERM_B_SN=LOT:04A0423
#### Channel B thermistor description (str[128])
THERM_B_DESC=THERM_A_SN=Channel B; YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration
#### Channel B thermistor calibration coefficients: Range 268.16 ->338.16K, -1.0 not used(double[10])
THERM_B_COEF=1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### Channel C thermistor serial number (str[80])
THERM_C_SN=LOT:04A0423
#### Channel C thermistor description (str[128])
THERM_C_DESC=Channel C; YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration
#### Channel C thermistor calibration coefficients: Range 268.16 ->338.16K, -1.0 not used(double[10])
THERM_C_COEF=1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### Channel D thermistor serial number (str[80])
THERM_D_SN=LOT:04A0423 # KT15 !!!
#### Channel D thermistor description (str[128])
THERM_D_DESC=Channel D; YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration
#### Channel D thermistor
THERM_D_COEF=1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#
######################### EOF #########################################
```

Appendix B: Minimum Software requirement for operation of the ISAR instrument.

a. Terminal software (PuTTY for Windows/DOS) that can upload ASCII files and capture the screen content of the terminal window to a ASCII file.
b. Text editor for editing the config file. Must be capable of sorting files in UNIX format (e.g.: Nano for onboard instrument editing, Ultraedit for Windows or kate/gedit for Linux)
c. SFTP and SSH client software.

Appendix C: Onboard computer reset procedure

At Linux prompt type `Reboot` as root.

Alternatively, switch power to onboard computer off.
Wait 30 minutes for UPS to discharge.
Switch power back on and allow ISOC to run.