



National Oceanography Centre, Southampton

UNIVERSITY OF SOUTHAMPTON AND
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ISAR User Manual v1.11

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1 Introduction

The Infrared Sea surface temperature Autonomous Radiometer model 5 (ISAR5) has been developed to provide accurate and reliable measurements of the radiative sea surface temperature (SST_{skin}) to an accuracy of ± 0.1 K, by measuring infrared emission from the sea surface and atmosphere in the spectral waveband 9.8-11.5 μm (see Table 1.1), without the need for frequent operator intervention. One of the major problems with obtaining accurate SST_{skin} measurements from ships has been adequate environmental protection of delicate infrared radiometer fore-optics. Sea-water 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 SST_{skin} measurements alone are often of marginal value in most applications, additional meteorological or oceanographic instrumentation can be connected to the ISAR5 system to provide a complete user specified measurement package.

Table 1.1 ISAR5 instrument Specifications

Spectral range	9.6-11.5 μm
Response time	0.05-10s (user defined)
SST _{skin} Accuracy ¹	± 0.1 K rmse.
Temperature range	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	15V DC

This operations manual describes the configuration, operation and deployment of an ISAR5² 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. Several procedures are described that may be performed by a competent technician. Their inclusion is meant to be a 'last resort' should things go wrong at sea without the ability to return the ISAR instrument to base for a proper service and repair.

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 with care and attention as damage to your ISAR instrument may occur.

It is assumed that you as a user are competent with handling PC computers, software installation, basic wiring of plugs and have a competent understanding of making infrared measurements of the sea surface and atmosphere.

¹ Depending on the appropriate value for the emissivity of seawater

² Note that henceforward the user manual will refer to the ISAR5 instrument as ISAR.

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 $\sim 25^\circ$ 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.

i Do 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.

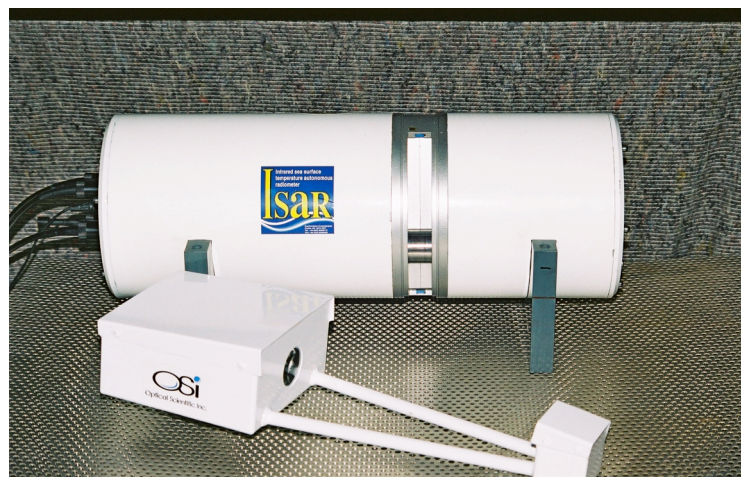


Figure 2-1. The ISAR-5 radiometer and Optical rain gauge.

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 ISAR5 CD-ROM.

Table 2-1. ISAR5 component list.

Item code	Number supplied	Description
ISAR5-01	1	ISAR-5C instrument
ISAR5-02	1	Optical rain gauge
ISAR5-03	1	Trimbell GPS magnetic antenna
ISAR5-04	1	Cable for Mini-ORG
ISAR5-05	1	Power pigtail for ISAR-5
ISAR5-06	1	Communications pigtail for ISAR-5 instrument
ISAR5-08	1	Small spot size laser for optical alignment with manual
ISAR5-09	1	KT15 lens mount for laser
ISAR5-10	1	US-Digital shaft encoder configuration interface card
ISAR5-11	1	ISAR5 operational software CD.
ISAR5-12	1	ScTI Mini-ORG optical rain gauge operations manual
ISAR5-13	1	Trimbell GPS operations manual
ISAR5-14	1	Tattletale operations manual
ISAR5-15	1	Heitronics KT15.85D operations manual
ISAR5-16	1	Heitronics KT15.85D instrument data (3.5" floppy disk)
ISAR5-17	1	Calibration certificate
ISAR5-18	1	CD-ROM containing software/documentation etc

3 Getting Started

3.1 Connecting the ISAR system

This section of the ISAR manual explains how to:

1. Connect the ISAR Optical rain gauge to the ISAR instrument
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-5C instrument and the necessary connections to the external devices. Use this as a guide to connect the ISAR-5C system noting the orientation of the ISAR-5C using the 4 LED indicators as a guide.

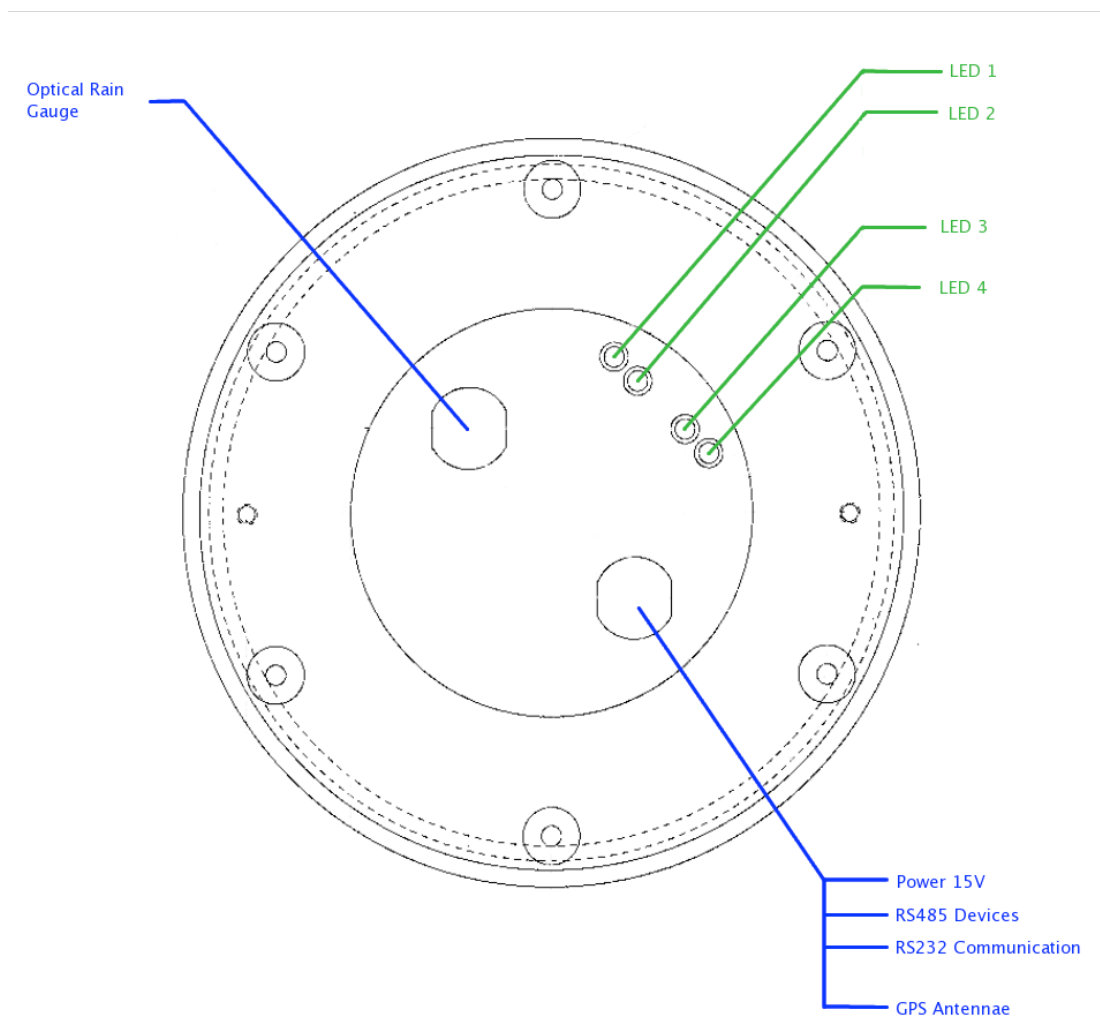


Figure 3-1 View of the ISAR end plate showing how external connections are made to the instrument. Use the indicator panel lights to orient the ISAR-5C body.

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	ORG Connector pin number
1	Screen	not used	not used
2	Black	Ground	E
3	Orange	Analogue Signal	A
4	Red	+12Volt DC	D
5	Yellow	not used	not used
6	Brown	Analogue Ground	B
7	Green	not used	not used
8	Blue	not used	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		Not used
2		Not used
3		Not used
4		Not used
5		Not used
6		Not used
7		Not used
8		Not used
9		Not used
10		Not used
11		Not used
12		Not used
13	Black	RS 232 GND
14	Brown	RS 232 TX
15	Orange	RS 232 RX
16		RS485 12V GND
17		RS485 12 V Power
18		RS485 TX +
19		RS485 RX -
20		GND
21		POWER IN 15V
22		GND

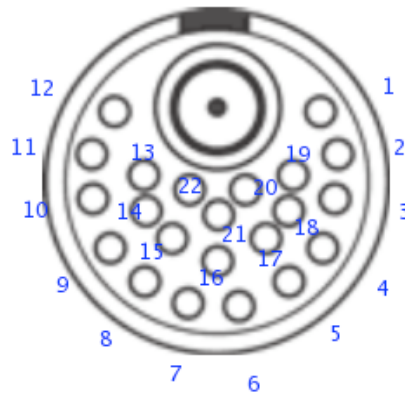


Figure 3-2: LEMO EGG.3K.822 socket view from the solder side.

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

Table 3-3 Serial communications parameters for ISAR serial interface

Name	Setting
Baud	9600
Data Bits	8
Stop Bits	1
Parity	None
Handshake	None

i Ensure that the *correct voltage* is set on the power supply unit (15-16 V DC) and always use an uninterruptible power supply with a current limit facility. If the input power falls below 15V DC the on board TT8 computer may require a hard power reset as the internal registers may be corrupted. ***This may be difficult to determine as the ISAR system and operational code may continue to operate but all data registers within the TT8 system will be corrupt and thus, the data will be incorrect!***

The ISAR on-board computer is a Tattletale Model 8 (TT8) manufactured by Onsett computer corporation and further information can be found at <http://www.onsetcomp.com/>.

For operational deployments, use an uninterruptible power supply.

bomb 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 ISAR5 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. Please use an appropriate cradle to secure your ISAR before power up. The ISAR storm shutter may be damaged if not protected. Please ensure that the shutter is free to rotate when in the laboratory or when deployed.
3. Please be aware that the torque on the ISAR storm shutter is significant. **Please be aware that you can severely injure your fingers if they are trapped by the ISAR storm shutter.** In addition, if a foreign body gets trapped by the shutter then significant damage to the storm shutter mechanism will occur.
4. The ISAR instrument is normally delivered with the storm shutter in the closed position but this may open automatically on power up.
5. The RS485 connector carries 12 V DC power. Please make sure the contacts, as described in section 3.2.2, are properly insulated when not in use.
6. Please be aware that the ISAR instrument weighs ~20 kg and 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 which are located inside the ISAR. It is normal for the scan drum to behave like this. Please protect the scan drum aperture 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:

1. Install ISAR software on a computer that will be used to control the ISAR instrument

Please 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-5C software distribution

Directory structure	Contents and purpose
\doc\ISAR	Contains the ISAR manual
\doc\manuals	The manuals for the Tattletale computer, the PNI module and the Trimble GPS module
\software\ISAROS	Contains executable (*.rhx and *.ahx) TT microcomputer files and proto118.run 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.
\software\CrossCut	Directory containing CrossCut communications program

It is assumed that the user has installed the CrossCut v2.08 program and read through the documentation supplied on the ISAR CD-ROM before proceeding further.

6 Communicating with and testing the ISAR

The ISAR instrument is shipped with a basic diagnostic program called proto which can be used to familiarise yourself with the ISAR system and to test all of 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

To operate, the ISAR requires connection to a personal computer running Microsoft Windows or LINUX operating system. Only the DOS/Windows systems will be considered here and in the case of LINUX or any other operating system please ask the ISAR team for advice.

The ISAR onboard computer (TT8) communicates with a host computer through a serial port via a resident mini-monitor program called TOM8. The TT8 computer can accept and execute C programs, interact with a user and offload logged data for final analysis. A communications interface is required on the host computer and the Windows HyperTerm program is adequate for this purpose.

On initial power up the ISAR should automatically run the isaros software code that is stored in the TT8 EEPROM. On power up, check the configuration of ISAR using Table 6-1.

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

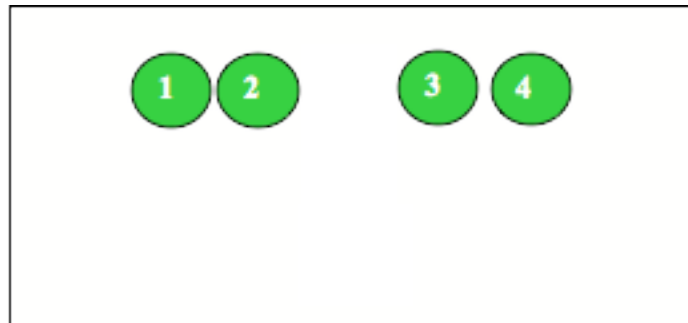


Figure 6-1 ISAR-5 status lights layout


Figure 6-1 shows the layout of the LED status lights and Table 6-1 describes their function. The LEDs 3 and 4 will be orange if both possibilities are switched on.

Table 6-1 ISAR-5 status lights function

Position	Color	Indicates...
1	Green	Heartbeat (blinking if OK) – this LED also indicates that the ISAR has power.
2	Red	Indicates status of watchdog timer - If lit, timed out
3	Green	KT15 power on/off (lit/unlit)
3	Red	Spare power on/off (lit/unlit)
4	Green	BB2 heater on/off (lit/unlit)
4	Red	BB1 heater on/off (lit/unlit)

6.2 The ISAR diagnostics software (PROTO nnn)

A generic diagnostic program called PROTO nnn (where nnn refers to the release version of the codebase e.g. PROTO118) is supplied with the ISAR instrument to help familiarize you with the instrument and to assist in diagnosing any problems you may encounter. A copy of this program can be found in the \bin subdirectory of the ISAR-5C CD-ROM.

 A copy of the Proto executable code is also available on the ISAR Compact Flash card (called Proto nnn .RUN). While in PicoDOS, this program can be executed by typing its name and pressing enter (see section 7 below for details of how to access the ISAR Compact Flash card).

The PROTO nnn software is stored as an executable file located on the ISAR compact flash card (see section 7.1).

6.3 Testing the ISAR instrument

After the ISAR instrument is switched on the ISAROS software will boot and run the instrument as specified in the isarconf.icf file on the flash card. To run the PROTO nnn program the isaros has to be stopped by either pressing Y during the startup (before the ISAROS reads the isarconf.icf file) or by pressing Q after the startup routine has finished. Table 6-2 describes the command set of the PROTO nnn program.

Table 6-2 Command set for the PROTO nnn program (Proto111, 2003-06-06)

Key	Description	Expected result
>	Selects the Engineering menu option page	Screen presents engineering menu command options
(Computes a Mean and Standard deviation of Mini-ORG measurements for use in the isarconf.icf file	Mean and SD calculation results are presented
\$	Prints the contents of the flashcard file ISARDATA.DAT	The entire ISARDATA.DAT file is printed to the screen allowing it to be captured and saved.
?	Selects the Operational menu page	Screen presents operational menu command options
[Executes the EnableEncoder() function	Enables the USDIGITAL shaft encoder for comms
]	Executes the DisableEncoder() function	Enables the USDIGITAL shaft encoder for comms
*	Obtain data over a scan drum arc (Useful to scan over the black bodies)	Points scan drum to an initial position, increments the scan drum position until position 2 is reached. Prints data for each scan drum position
a	Turns the ISAR spare power line on/off	LED 3 red (Fig 5.1) on/off
A	Turns the KT15 on/off	LED 3 green LED 6 (Fig 5.1) on/off
b	Turns BB1 heater on/off	LED 4 red (Fig 5.1) on/off
B	Turns BB2 heater on/off	LED 4 green (Fig 5.1) on/off
C	Sends a command to an RS485 device	Sends a command to the RS485 system
C	Reads all channels of the AD 4017 unit	Prints values (counts) to the screen
d	Opens the ISAR-5C shutter	Opens the shutter
D	Closes the ISAR-5C shutter	Closes 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)
F	Write a test string the ISAR-5C flashcard	A flashcard file is opened and a string is written to this file.
F	Set the shaft encoder reference position	Sets the zero position of the shaft encoder and stores the data on the encoder eeprom.
g	Read data from the GPS unit	Prints raw data read from the GPS unit (See section 8)
G	Set the ISAR-5C real time clock using the GPS signal	Sets the ISAR-5C real time clock to the UTC time value reported by the GPS unit.
h	Read the Target temperature reported by the KT15.85D	Prints data to the screen
H	Send a command to the KT15.85D	Prints a reply string from the KT15 (See KT15 manual for more information)
I	Moves the scan drum in the forward direction	Scan drum moves continuously until a key is pressed

Key	Description	Expected result
I	Moves the scan drum in the reverse direction	Scan drum moves continuously until a key is pressed
J	Moves the shutter in the open direction (Careful not to run the shutter off the drive belt !!)	Shutter moves continuously until a key is pressed
J	Moves the shutter in the close direction (Careful not to run the shutter off the drive belt !!)	Shutter moves continuously until a key is pressed
k	Not used	
K	Switches the Thermistor Power VRef on	
I	Not used	
L	Read all of the analog channels	All analog channel data printed to screen until a key is pressed
M	Not used	
M	Not used	
n	Not used	
N	Not used	
o	Read the ScTi Optical rain gauge	Optical rain gauge data printed to screen
O	Test routine to check that rain gauge signal closes the ISAR shutter	Opens the shutter and watches the rain gauge for rain. IF a signal is detected (e.g., by wagging your fingers in front of the rain gauge sensor) the shutter will close.
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 Proto program and return to the TOM8> prompt	Returns to TOM8> prompt
Q	Not used	
r	Reads the current ISAR-5C real time clock	Prints date and time to the screen
R	Sets the real time clock from the Tattletale time	Sets time
s	Not used	
S	Read the status of the shutter Hall effect switches	Prints data to the screen
t	Read the Tattletale electronics board temperature, the window temperature	Prints data to the screen
T	Read BB1 and BB2 temperatures	Prints data to the screen
u	Show the current time setting of the Tattletale	Prints data to the screen
U	Set the Tattletale clock using yyymmddhhmmss	Set the TT8 clock
v	Read the input power voltage	Prints data to the screen
w	Read the KT15 internal reference temperature	Reads the digital KT15 reference (internal) temperature
W	Read the KT15 target temperature	Reads the target temperature measured by the KT15

Start the CrossCut/HyperTerm interface and you should be presented with a menu of PROTO nnn options. Pressing ? will recall this menu screen at any time. As you can see, a command is executed by typing a letter which is case sensitive. Some commands have additional requirements and you will be prompted by the program to enter appropriate data. The command menu is summarized in Table 6-2.

The PROTO nnn program can be used to test the ISAR-5 instrument in order to make sure that no damage has occurred during transportation. The following tests should be executed:

- Check that the heartbeat LED is flashing.
- Check that the shutter opens and closes. You can use commands d and D for this purpose. Check that the shutter opens completely and closes completely and that excessive current is not drawn during this operation (this is done by chcing 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 setting the scan drum to point at an angle of 4.5°. When 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-5C body.
- Check that the KT15 reports meaningful data (typical range of 3-4 V at room temperature when set to use a range of -100°C to 100°C)

- Check the Blackbody thermistor ranges using command T.
- Check the Blackbody heater circuits by first switching each BB heater off and collecting some data. Now turn each black body heater back on and collect data (you may have to wait a few minutes for the BB's to warm up a little).
- Check the rain sensor. You should be able to generate a test signal by moving your fingers in front of the sensor.
- 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, you are ready to begin using the ISAR.

7 Using the ISAROS[®] operational data logging software

ISAR allows considerable flexibility for defining how the instrument will make measurements for an operational deployment using the ISAROS (ISAR Operating System). This section of the ISAR manual explains how to:

1. Access the ISAR compact flashcard using PicoDOS functions
2. Upload a new ISAROS executable program to the TT8 computer
3. Store a file on the Compact flash card
4. Load a new ISAROS executable program into the ISAR EEPROM
5. Configure the ISAROS software to make user defined measurements

7.1 Using the ISAR Compact Flash card and PicoDOS

The ISAR system has an internal 256Mb compact flash card that can be used to store programs, configuration files, calibration information and data files. To access the Flash card it is necessary to execute the Peripheral Issues Card Or Disk Operating System "PicoDOS" flash program by using:

g 2bcf8 at the TOM8> prompt³.

PicoDOS replicates most of the functionality of a "real" DOS, but embedded in TT8. The PicoDOS kernel and command shell provides you with transparent access to DOS compatible file functions. The following DOS Emulation Commands mimic the syntax and behavior of their DOS counterparts as shown in Table 7-1

Table 7-1 PicoDOS commands

Name	Purpose	Syntax
CAPTURE	Save a file from the Serial port	Capture <filename>
COPY	Copy fa file	copy <source filename> <destination filename>
DATE	Print/set the TT8 date	Date
DEL	Delete files	del <filename>
DIR	List files	dir [wildcards]
ERASE	Erase a file	erase <filename>
FORMAT	Format a compact flashcard	format [/Q]/[E]/[F]
TIME	Print/Set TT8 time	Time
TYPE	Print the contents of a file	type <filename>
REN	Rename a file	Ren <oldname> <newname>
VER	Print the software version	Ver
?	Print a help screen with syntax information	?



All commands are described in detail in the PicoDOS user manual in the \ISARC-Documentation subdirectory of the ISAR-5 CD.

7.2 Loading a new program onto the ISAR instrument

Before any program can be executed, it is necessary to load the program onto the TT8 computer. Two types of Motorola **S-record** programs are provided with the ISAR:

- *.RHX which is a *runtime hex* S-record file loaded to RAM
- *.AHX which is an *application hex* S-record file loaded to flash ROM.

³ The TOM8> prompt can be reached by pressing Q while the ISAROS is running or Y during the startup of ISAROS.

The major difference between these two program types is that an RHX S-record is *memory resident* (RAM) and needs to be re-loaded after each execution has terminated whereas an AHX record is *burnt onto the TT8 flash* which is described in the following section.

★ It is always wise to run the RHX version of your program first to check that all is well before loading an AHX file. Sometimes, if there is a programming error, it can be difficult to clear a program from flash without first disassembling an ISAR instrument!

7.2.1 Loading a new rhx program onto the ISAR-

To load a program into RAM, first make sure that the Terminal window is shown and the ISAR is connected and powered up. Press <return> a few times on your PC. You should keep getting the **TOM8>** prompt in the Terminal window. Select the Tattletale menu item while in CrossCut and then the Load S-record entry (short-cut is Alt-L). This sends the proper commands to the TOM8 monitor to allow a high-speed (57600 baud) load of an S-record executable program to the TT8.

❗ Complete information on the operation of the TT8 computer can be found in the documentation provided in the \Documentation\TT8-Manual directory on the ISAR CD-ROM.

You will be prompted to enter the file name of the S-record to be loaded. Use the TAB and cursor keys or the mouse to select the required RHX file and press ENTER when that file is highlighted. A dialog appears showing the process of the download. After the download you should see the following prompt:

```
TOM8>
load successful
```

To run the program, type g at the TOM8> prompt. This jumps to the starting address of the program (which the TOM8 monitor received from the S-Record) and executes it.

7.2.2 Storing a new program in the ISAR flash memory

Loading a program to Flash memory is very similar to loading to RAM. When the ISAR is powered up, the TOM8 mini-monitor will check for a program in Flash and execute this immediately. Thus, an application will automatically run at power-up or hardware reset if it has been burned into the ISAR Flash.

★ When loading a new AHX file to the ISAR this will overwrite the contents of the TT8 memory (e.g. the proto301.ahx program)!

To load the isaros.ahx program onto flash, first make sure that the Terminal window is shown and that the ISAR is connected and powered. Press return a few times on your PC. You should keep getting the TOM8> prompt in the Terminal window. Go to the Tattletale menu and choose **Load S-record** (or press Alt-L). A file dialog appears. You should use the TAB and cursor keys or the mouse to select your AHX and then press ENTER when that file is highlighted. A dialog appears showing the process of the download. After the download you should see something similar to the following prompt (the start and end address values may vary):

```
TOM8>
load successful

Target is Flash!
start addr = 00002000
end addr = 00006105
```

Ok to write flash between above addresses? (Y/N)

Press the y key to burn the program into Flash memory. The progress of the burn and the Flash ID are shown. To execute the program while at the TOM8> prompt type g. To verify that the new isaros.ahx program is in Flash, turn off power to the ISAR and then reapply it. The program should run automatically. Remember that you can always re-load an old flash resident program that you have overwritten.

7.2.3 Stopping the ISAR resident data logging program

When the ISAR is powered up, the ISAROS data logging program is automatically run. The initial factory configuration of the ISAROS code will make a SSTskin temperature measurement using a target view angle of 45° from nadir for the sea, 45° from zenith for the sky and 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.

By pressing Q the ISAROS data logging software should stop and place you at the TOM8> prompt.

7.3 Configuration of ISAR: Using the isarconf.icf file

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

The isarconf.icf file is an instrument configuration file that is read by the isar system every time the data logging program isaros is started. It is stored on the ISAR compact flash card. The isarconf.icf file is an ASCII text file with a very specific format. It contains instrument specific calibration data, component identifications and user configuration fields. The general format of the isarconf.icf file is for a comment line, denoted by a # at the start of the line, to be followed by a data line. For example

```
# ISAR-5C serial number (int)
2
```



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

In general, the comment line provides the format of the following data line. No comment line should exceed 255 characters in length. In general only a few isarconf.icf fields need to be changed by a user and these are discussed by task in the following sub-sections.



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

All of the fields that require user editing are provided at the start of the ISAR conf.icf file. Most entries should not be changed unless you are absolutely certain that you know what is required and that you understand the implications of your changes for the isaros data logging system and for your own 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 you have connected to the ISAR instrument.

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

```
# Title stating purpose of this isarconf file (str[255])
```



```
v719lab.icf ICF for ISAR-5C-005; Setup for BB cals, log to flashcard:ON, SST calculation:ON,
diagnostics:ON, Raw PNI output:ON raw GPS output:ON
# Author name, e-mail and telephone number (str[255])
C J Donlon (craig.donlon@jrc.it tel:+39 0332 786353)
# Last Edit date yyyy-mm-dd (str[15])
2003-06-05
```

7.3.1 Configuration of KT15.85D parameters

The KT15.85D may be configured to operate in a variety of different modes. The isarconf.icf 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 although these particular values are specific to instrument serial number 4801:

```
#
#### KT15.85D Serial number (int)
8115
#### Date and details of KT15.85D last calibration (str[255])
2007-05-11, Polynomials for R2T & T2R: TJ Nightingale 2003-06-04
#### KT15 emissivity setting command (0.001 -> 1.000) (str[15])
EPS 1.000
#### KT15 response setting command (0.05, 0.1, 0.3, 1 3 or 10 seconds) (str[15])
RESP 1.0
#### KT15 analog output setting command (Do you know what you are doing ?) (str[30])
ANALOG -100.0 50.0 C 3
#### KT15 serial interface setting (Do you know what you are doing ?) (str[20])
COM 96 8 1 n
#### KT15 Temperature to Radiance coefficients based on kt15 filter response (-1 not used) (double[9])
-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])
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.icf file in order that a cross check may be made between the KT15 by reading the serial number off the unit and the isarconf.icf value. This helps to avoid applying the calibration data for one KT15 unit to a different KT15 when more than one 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 response time default is 1.0s
5. The analog 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 computed based on the calibration data provided by Heitronics.

7.3.2 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 lines of the isarconf.icf file:

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

Notes

1. The park angle is an absolute rotary position that has a zero position depending on the ISAR-5 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.

7.3.3 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 $n \times 2$ seconds. A recommended choice of delay is $n \sim 350$. If you are working with the ISAR in the laboratory for a calibration, then a rain event delay is not required. Use the following lines of the isarconf.icf to reduce the shutter open delay following a rain event:

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

7.3.4 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 and this is set using an ORG V threshold using the following isarconf.icf lines:

```
##### Optical rain gauge rain V threshold below which shutter is closed (float). Lab=1.0, Field= ~0.062
0.062
```

During long deployments some surface contamination of the ORG optical system may occur and the V threshold value must be set with some margin of tolerance to allow for this. However, in this case there is an increased possibility of ISAR not closing down quickly once a rain/spray event has occurred. Typically, a rain event is characterized by a significant increase in the Standard deviation of the signal and a second threshold may be set to trigger the ISAR shutter based on the standard deviation of the ORG signal. A second check is made by computing the standard deviation of 25 ORG measurements and comparing this against a threshold value. The following lines of the isarconf.icf file may be used for this purpose:

```
#### Optical rain gauge rain V standard deviation above which shutter is closed (float). Lab=1.0, Field=
~0.0015
0.0015
```

Notes:

1. The V mean threshold should be verified by basic tests before unattended deployments at sea. A guide value of 0.056-0.066 is typical.
2. The V standard deviation threshold should be verified by basic experiments before deployments at sea using the Proto code (option ' '). A guide value of 0.002 is typical.

7.3.5 Setting the Shaft Encoder Reference position

The shaft encoder reference position must be set in order for the ISAR scan drum to be able to position itself correctly. A simple method to check the configuration is 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. Use the Proto software to do this. The scan drum position should read 355.5° in this position. If this is not the case, an appropriate zero offset may be set using the following isarconf.icf lines:

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

Notes

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

7.3.6 Setting the heated black body

Both ISAR BB units are identical and 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 and the other is not heated so that it remains at about ambient temperature. Normally, the upper (325°) BB unit (BB2) should be selected as the heated BB since this points down, preventing heat loss by air advection from the cavity when the scan drum aperture opens the aperture. The following lines of the isarconf.icf must be used to configure the BB heater system:

```
#### Heated (Active) blackbody (1 or 2; 2
2
```

7.3.7 Logging data to the ISAR compact Flashcard

The ISAR system has a 256Mbyte compact flashcard 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 Compact flashcard is turned ON by setting the first flag in the isarconf.icf file using the following lines:

```
#### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data
4=print raw GPS data, 5=print $IS5MR data, 6=print $I5CAL record 7=run blackbody crossing temperature
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature
shutdown (int[10])
1,0,0,0,0,0,0,0,0,0
```

7.3.8 Configuring ISAR measurement angles

The ISAR can be configured to obtain data from a target at any angular position (0-360°) by setting the scan drum angle to a given angular location. Experience shows that 10 positions are sufficient for most applications and the isarconf.icf file can be used to specify 10 “set” scan drum positions using the following line in the isarconf.icf file:

```
#### 10 scan drum measurement angles -1 if not used (float, spearator=',') BB1,BB2,sea,sky...
280.0,325.0,25.0,90.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
```

In this example, four target views will be sampled sequentially in the order from left to right (280, 325, 90 and 25 degrees). The remaining six positions are not set (indicated by a -1.0 that is used to denote a null angle).

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

The number of samples to be made at each measurement angle, and which are averaged together in the SSTskin calculation and output as \$IS5MR data records (see Section **Error! Reference source not found.**), must be set using the following lines of the isarconf.icf file:

```
# 10 Number of samples for each target view. -1 if not used (int)
30,30,30,15,-1,-1,-1,-1,-1,-1
```

Note that there is a one-to-one correspondence between the list of scan drum angles and the list of the number of samples so that in the example given here, 30 samples will be made at angles 280°, 325° and 90° but only 15 samples will be made at angle 25°.

Notes:

1. Please ensure that exactly 10 entries are made for the scan drum target position and the sample numbers - otherwise the isarconf.icf may not be read correctly at boot.
2. It is possible to set a complex measurement sequence of alternate BB and target views using this method.
3. Angular positions are accurate to approximately 0.1 degree

7.3.9 Requesting ISAR to provide a real time SSTskin data record

The ISAR can also compute a real time SSTskin data record. This can be requested using the flags line of the isarconf.icf file as follows:

```
#### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data
4=print raw GPS data, 5=print $IS5MR data, 6=print $I5CAL record 7=run blackbody crossing temperature
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature
shutdown, 10=ORG warm up delay(int[20])
0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
```

In order for a SSTskin temperature to be properly derived from raw ISAR measurements the isarconf.icf file must specify which measurement angles to use to determine the sea radiance and sky radiance and what the appropriate seawater emissivity value is for a given deployment geometry. Initially, a user must set the view angles for which ISAR will collect measurements. Following on from the other example settings described above, in this example, scan drum angle 2 (90.0°) will be used as the target “sea view” angle, scan drum angle 3 (25.0°) will be used as the target “sky view” angle and an emissivity value of 0.991635 will be used for the emissivity of seawater. As several different sea and sky angles may be defined in a typical measurement sequence, the SSTskin calculation must know which data to use for sea and sky measurements. The following lines in the isarconf.icf file may be used for this purpose:

```
#### SST real time calculation setup (double): 0=seaview drumangle index,1=skyview drumangle
index,2=seawater emissivity,3=RMR x correction factor, 4=Vref (0 uses measured Vref), 5=Rref, 6=internal
bb emissivity (std: 0.9993),7=SelfHeating correction on/off,8-9=empty
3,2,0.991635,1.0,5.10,10000.0,0.9993,1.0,-1.0,-1.0
```

where the first number is the index to the scan drum angle defined above that will be used as the target view (sea view) data (in this example, index 2 refers to a scan drum angle of 90.0° and 30 samples). The second value provides the index to the scan drum angle that will be used to collect sky view data (in this example, index 3 refers to a scan drum angle of 25.0° and 15 samples). The third number provides the emissivity of seawater for the sea view angle and viewing geometry of the ISAR system specific to each deployment scenario. In this example it is 0.991635 (valid for a view angle of 25° from nadir).

Finally, data logging to the Compact flashcard is turned ON by setting the first flag in the isarconf.icf file using the following lines:

```
#### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data
4=print raw GPS data, 5=print $IS5MR data, 6=print $I5CAL record 7=run blackbody crossing temperature
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature
shutdown, 10=ORG warm up delay(int[20])
1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
```

Notes

1. If the emissivity value is out of bounds (i.e., <0 or > 1.0), ISAR will not boot.
2. Attention should be given to ensure that the SST real time setup is valid in each case otherwise the SSTskin temperature data will be in error.
3. A sufficient 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 the emissivity values specified for the sea surface can be selected to be appropriate for the intended viewing angle. This may be verified using the PNI roll values.

7.3.10 Requesting ISAR to provide diagnostic data at boot

A summary of ISAR data outputs can be requested at the startup of the isaros program. This capability can be used to check the functionality of the ISAR system and isarconf.icf file. This function is requested by setting the appropriate flag in the isarconf.icf file using the following lines:

```
##### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data
4=print raw GPS data, 5=print $TS5MR data, 6=print $I5CAL record 7=run blackbody crossing temperature
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature
shutdown, 10=ORG warm up delay(int[20])
0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
```

7.3.11 Requesting ISAR to log raw GPS data

The raw output from the ISAR on-board GPS system can be placed onto the ISAR data stream by setting the appropriate flag in the `isarconf.icf` file using the following lines:

```
##### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data  
4=print raw GPS data, 5=print $TS5MR data, 6=print $I5CAL record 7=run blackbody crossing temperature  
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature  
shutdown, 10=ORG warm up delay(int[20])  
0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
```

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

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

The raw output from the ISAR on-board compass system can be placed onto the ISAR data stream by setting the appropriate flag in the `isarconf.icf` file using the following lines:

```
##### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data  
4=print raw GPS data, 5=print $TSMR data, 6=print $I5CAL record 7=run blackbody crossing temperature  
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature  
shutdown, 10=ORG warm up delay(int[20])  
0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
```

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

7.3.13 Requesting ISAR to print a \$IS5MR record to the standard output

You can request that the \$IS5MR data record (stored on the Internal compact flash card) is also output to RS232 by setting the appropriate flag in the isarconf.icf file using the following lines:

```
##### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data  
4=print raw GPS data, 5=print $IS5MR data, 6=print $I5CAL record 7=run blackbody crossing temperature  
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature  
shutdown, 10=ORG warm up delay(int[20])  
0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
```

7.3.14 Requesting ISAR to print a \$ I5CAL record to the standard output

You can request that the \$I5CAL data record (stored on the Internal compact flash card) is also output to R232 by setting the appropriate flag in the `isarconf.icf` file using the following lines:

```
##### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data
4=print raw GPS data, 5=print $IS5MR data, 6=print $I5CAL record 7=run blackbody crossing temperature
```

```
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature
shutdown, 10=ORG warm up delay(int[20])
0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0
```

7.3.15 Requesting ISAR to run the BB crossing temperature routine

You 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 to enter the routine is 0.5V (This value is fixed and can not be changed in the configuration file). The BB crossing event can be switched on by setting the appropriate flag in the isarconf.icf file using the following lines:

```
#### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data
4=print raw GPS data, 5=print $IS5MR data, 6=print $I5CAL record 7=run blackbody crossing temperature
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature
shutdown, 10=ORG warm up delay(int[20])
0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0
```

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

You can request that the ISAR instrument shuts down when the preset roll or pitch limit (see **Error! Reference source not found.**) is exceeded. The instrument follows the standard rain routine for the shutdown and will return to normal operation when the roll or pitch reduces to below the limit and the rain event countdown has finished. The roll or pitch shutdown can be switched on by setting the appropriate flag in the isarconf.icf file using the following lines:

```
#### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data
4=print raw GPS data, 5=print $IS5MR data, 6=print $I5CAL record 7=run blackbody crossing temperature
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature
shutdown, 10=ORG warm up delay(int[20])
0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0
```

7.3.17 Requesting ISAR to shutdown for low temperatures

You 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 when the ambient temperature is above 273.15K and the rain event countdown has finished. The low temperature shutdown can be switched on by setting the appropriate flag in the isarconf.icf file using the following lines:

```
#### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data
4=print raw GPS data, 5=print $IS5MR data, 6=print $I5CAL record 7=run blackbody crossing temperature
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature
shutdown, 10=ORG warm up delay(int[20])
0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0
```

7.3.18 Requesting ISAR to wait for the ORG to warm up

You can request that that the ISAR instrument will wait 30 measurement cycles for the ORG measured voltage to drop below the limit set in 7.3.4. If the either the measured voltage drops below that limit or the 30 measurement cycles have been completed the warming up loop stops and the measurement loop starts.

```
#### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data
4=print raw GPS data, 5=print $IS5MR data, 6=print $I5CAL record 7=run blackbody crossing temperature
routine $XTEMP in rain event, 8=roll and pitch limit exceedance shutdown, 9=freezing temperature
shutdown, 10=ORG warm up delay(int[20])
0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0
```

7.3.19 Changing PNI TCM-2 pitch and Roll alarm limits

During a given deployment, should a ship exceed certain roll and pitch limits the ISAR system will flag \$ISAR5 data records accordingly using the 7th and 8th bits of the `StatusWord` (see section 8) The following lines of the `isarconf.icf` file may be used for this purpose:

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

Notes:

1. Pitch and roll limits are used to provide warnings only, reported via the `StatusWord` bits 7-8
2. If Flag 8 of the USER FLAGS (see **Error! Reference source not found.**) is set the instrument will shut down (ISAR behaves like it would in a rain event)

7.3.20 Using the ISAR RS485 sub-system

The ISAR provides a means to connect RS485 devices to the main system and log data from these devices directly into the ISAR data stream. For each RS485 device the following parameters must be set in the `isarconf.icf` file:


- (a) A label for the device
- (b) The RS485 address
- (c) The device specific read command
- (d) A bit delay in milliseconds

Each RS485 device should be configured at 9600 baud, with no stop bits and no parity. The following `isarconf.icf` lines are provided for RS485 configuration:

```
#### 8 External RS485 device description (str[8][80] separate fields with ',', Default=NoDevice)
RhoPD_D1102_CM11Solarimeter,NoDevice,NoDevice,NoDevice,NoDevice,NoDevice,NoDevice,NoDevice
#### 8 External RS485 device address (0x03 and 0x0E are reserved) (int[8], default=-1)
4,0,0,0,0,0,0,0
#### 8 External RS485 device data read command (str[8][30] separate fields with ',', Default=NoCommand)
$4RD,NoCommand,NoCommand,NoCommand,NoCommand,NoCommand,NoCommand,NoCommand
#### 8 External RS485 device bitdelay (int[8] separated by ',', Default=-1)
12000,-1,-1,-1,-1,-1,-1,-1
```

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`. The bit delay for this device is `12000`.

Notes

1. No spaces are allowed in the device description fields which should not exceed 80- characters per device
2.  RS485 device address `0x0E` (encoder address) and `0x03` (AD 4017 address) are reserved
3. 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.

7.3.21 Configuration of ISAR basic measurements - summary

To make a basic set of radiance and SSST measurements the ISAR instrument needs to be configured appropriately. The `isaros` data logging program collects data in measurement cycles. A measurement cycle consists of the following measurements:

- BB1 calibration data
- BB2 calibration data
- Target observations


Note that the isaros program allows you to select up to 10 programmable target scan drum positions specified as angles. ISAR-5C must first collect n measurements viewing BB1, n measurements viewing BB2 and then for each target position it will make x measurements before moving on to the next target position. Finally, n measurements viewing BB1 and n measurements viewing BB2 will be made so 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 are to be set, including viewing the BBs?
- What are the numbers of samples at each scan drum position?
- Should data be logged to Flashcard?
- Should an SSTskin measurement be made (if so setup the calculation)?
- Should GPS data be logged?
- Should PNI data be logged?

The isaros data logging program will:

- Check the ISAR systems and initialize each of them
- Read the user defined configuration settings for this execution from the isarconf.icf file stored on the ISAR flash card
- Dump out the current instrument configuration
- Begin logging data.

 Be sure to capture all of the data to a file on the host computer using the CrossCut Capture to file facility by invoking ctrl-z before starting the ISAR data logging program !!!

8 ISAR data record format

The ISAR data stream is a formatted comma separated variable (csv) data record as a NMEA style ASCII string output. Several NMEA style identifiers are used to define the different ISAR5 data record types which are defined in **Error! Reference source not found.**

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

NMEA style identifier	Description
\$ISAR5	A standard ISAR-5 data record
\$IS485	A data record containing external RS485 device outputs
\$IS5MR	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
\$GPRMC	GPS data: Recommended minimum Specific GPS/Transit data
\$GPGGA	GPS fix data (NMEA version 2.1)
\$PNIST	TCM2 Electronic compass data record
\$ISMSG	A comment or message string
\$CONFIG	Configuration data and messages relating to the isarconf.icf configuration file
\$DIAGN	Diagnostics test outputs

Each data record type is fully expanded in the sections below. Note that these records are valid for the isaros v7.2 code base and above.

8.1 \$ISMSG data records

Various \$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 ISO 8601 standard format for a single variable date+time having the format

YYYYMMDDTHHMMSS

For example, we might expect the following when ISAR-5C is unable to obtain GPS information when there are no satellites in view:

```
$ISMSG,20030523T134522,WARNING: Bad GPS record
$ISMSG,20030523T134522,KT15 is now turned ON
$ISMSG,20030523T134522,isarconf.icf last edit date: 2003-03-05
$ISMSG,20030523T134522,ISAR-5C ID: 5
```

\$ISMSG strings are categorised as WARNINGS or as FATAL, where the latter prevents the onboard isaros data collection system from running (normally due to a badly configured isarconf.icf file).

8.2 Standard data record format (\$ISAR5)

A standard ISAR data record is produced approximately every second by the ISAR system. Each sensor on board the ISAR is read and the data value is stored in the lowest processed state. This constitutes the level-0 engineering data output. The format of an \$ISAR5 record is fully described in **Error! Reference source not found.** and **Error! Reference source not found.** If any external RS485 devices are attached to ISAR and correctly configured in the isarconf.icf file, a \$IS485 data

record will be produced to output the measurements made by each 485 device. The format of a \$IS485 record is shown in **Error! Reference source not found..**

Table 8-2. Format of \$ISAR5 data record (isaros-v7.2 2004/03/14)

CSV Position	Example	Units	Description	Format
0	\$ISAR5		NMEA style identifier	String
1	20030523T134544Z	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	1/4382	ISARID/KT15ID	Serial number of ISAR instrument and serial number of KT15 instrument (e.g.,1/4832)	Char

Table 8-3. Interpretation of the \$ISAR5 data record status word bit field (isaros-v7.2 2004/03/14)

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 (isaros-v7.2 2004/03/14). Note that at least 1 external RS485 device must be correctly configured in the isarconf.icf 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 ISAR instrument 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 output might be

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

but if two external RS485 devices (one multi-channel and one single-channel) were connected the output would be something like

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

8.3 Averaged data record format (\$IS5MR)

An averaged ISAR data record is the mean value of a number of standard data records obtained for a given scan drum position. A new \$IS5MR data record is created for each new scan drum position. The format of a \$IS5MR record is fully described in Table 8-5. Users may request that \$IS5MR data are stored to the ISAR-5 compact flashcard data file isardata.dat by setting user flag[0] in the isarconf.icf file stored on the isar-5 compact flash card. (See section 7.3.7)

Note that a \$IS5MR record will be terminated by the ISAR instrument ID field regardless of the number of outputs.

Table 8-5. Format of a \$IS5MR data record (isaros-v7.2 2004/03/14)

CSV Position	Example	Units	Description	Value and format
0	\$IS5MR		NMEA style identifier	String
1	20030523T134544 Z	yyyymmdd Thhmmss Z	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
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 BB1 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

CSV Position	Example	Units	Description	Value and format
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
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

CSV Position	Example	Units	Description	Value and format
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	2/2853	ID/Serial	ISAR-5 instrument ID+kt15 serial	Integer

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

If a user has requested that ISAR-5 calculates the SSTskin in real time by setting user flag[1] in the isarconf.icf 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 sufficient data are available for a real time SSTskin calculation. Note that for the SSTskin calculation to be valid, the isarconf.icf 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 7.3.7). 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 compact flashcard data file isardata.dat by setting user flag[0] in the isarconf.icf file stored on the isar-5 compact flash card.

Table 8-6. Format of a \$I5SST data record (isaros-v7.2 2004/03/14)

CSV Position	Example	Units	Description	Value and format
0	\$I5SST		NMEA style identifier	String
1	20030523T134544Z	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
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

CSV Position	Example	Units	Description	Value and format
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	2/2853	ID/Serial	ISAR-5 instrument ID+kt15 serial	Integer

Table 8-7. Format of a \$I5CAL data record (isaros-v7.2 2004/03/14)

CSV Position	Example	Units	Description	Value and format
0	\$I5CAL		NMEA style identifier	String
1	20030523T134422Z	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	1/4832		Isar id/kt15 id	

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

The raw output of the on-board GPS receiver is placed onto 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 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	1/4832		Isar id/kt15 id	

Note that if insufficient data are available due to a lack of visible GPS satellites no data will be shown but the commas of the csv format will be shown.

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

The raw output of the on-board GPS receiver is placed onto 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 \$GPRMC 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	1/4832		Isar id/kt15 id	

Note that if insufficient data are available due to a lack of satellites no data will be shown but the commas of the csv format will be shown.

8.7 TCM2 Electronic compass record format (\$PNIST)

The raw output of the on-board Precision Navigation TCM2 electronic compass module is placed onto the ISAR-5 data stream. The 2 standard output data record provided by the ISAR instrument has the following format

\$PNIST,\$C<compass>\$P<pitch>\$R<roll>\$T<temperature>*<checksum>

for example

\$PNIST,\$C151.2P-1.0R-3.2T27.5*22,1/4832

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
2/2853	ID/Serial	ISAR-5 instrument ID+kt15 serial	Integer

8.8 Diagnostic data record format (\$DIAGN)

ISAR diagnostic data are collected when the ISAR instrument is booted and is prefixed by the \$DIAGN NMEA style identifier. The data are not used for any purpose other than to identify them as diagnostic data during the instrument startup process. If a \$DIAGN output is requested, diagnostic data are written to the stdout and a delay of 10s is provided for the user to quit the deployment if required.

9 Maintenance

The proper and regular maintenance of your ISAR-5C instrument is fundamental to ensuring that accurate and dependable data are obtained. All components have been selected for their resistance to the harsh marine atmosphere and seawater but inevitably, after long deployments, optical and mechanical components will require a thorough service. It is recommended that **deployments do not last longer than three months** between the servicing procedures described in this section.

9.1 General maintenance

After every deployment:

- Check and service the shutter system
- Check and service the ScTi ORG
- Check and service the ISAR Mirror
- Check and service the ISARZnSe window
- Check and service the scan drum bush bearings
- Check and service the scan drum main bearing
- Check and service shaft encoder shaft seal
- Check and service shutter motor shaft seal
- Check and service shaft encoder to drive motor coupling
- Check and service all external plugs
- Check and service all external cables


 It is wise practice to ensure that a proper calibration is obtained before and after any maintenance activity.

The following sections describe in detail several maintenance procedures including:

- Replacement of the ScanDrum mirror
- Reconfiguration of the US Digital shaft encoder
- Replacement of the ZnSe window
- Configuration of the PNI TCM-2 sensor

9.2 Replacement of mirror (Procedure RM)

This procedure describes the steps required to replace the scan drum mirror located within the scan drum assembly. While a fairly simple operation, this requires that the ISAR is disassembled and the scan drum assembly removed. Be sure to allocate sufficient space on the workbench for this procedure preferably in a clean dust free laboratory to avoid contamination of the optical components. Be sure to revise the instrument maintenance record spreadsheet (ISAR-5C-instrument-???.xls) !!

 The gold plated mirror used in the ISAR system uses a copper substrate and is consequently a brittle structure that can be easily broken. Furthermore, the protective coatings deposited onto the gold surface may easily scratch. For all these reasons, please use extreme care when handling the ISAR mirror using fresh rubber gloves in a clean room.

9.2.1 Equipment and supplies

For this procedure you will need the following tools:


- 5 mm hex spanner
- small flathead screwdriver
- M5 socket nut spanner
- M6 socket nut spanner

You may need the following replacement ISAR-5C components and supplies:

- 1 x Replacement Gold mirror window (Part#: IS5-SOC-004)
- 2 x O-ring seal for outer casing (Part#: IS5-SOC-046)
- 6 x Dowty washers (Part#: IS5-SOC-040)
- 6 x M6 Dome nuts (Part#: IS5-SOC-037)
- Silicone grease
- Rubber gloves
- Acetone
- Lint free cloth

9.2.2 Procedure RM

Follow these steps to replace the ISAR-5C scan drum mirror:

- RM-1 Make sure the ISAR-5C shutter is in the open position before commencing this procedure.
- RM-2 Place the ISAR instrument standing with its cylindrical axis vertical and the drive body (the short body section) at the top.
- RM-3 Remove the ISAR drive body end cap by undoing the 6 dome nuts holding it in place. Remove the Dowty washers beneath.
- RM-4 Using the tool provided, release the end cap from the drive body. This may be a particularly tight fit and requires patience.  **do not use excessive force!**
- RM-5 Remove the end cap and inspect the o-ring seal. Replace with part IS5-SOC-047 as required.
- RM-6 Remove the outer casing. Inspect the O-ring on the main body and replace with part IS5-SOC-047 as required.

- RM-7 Remove the 6 retaining rods now visible by unscrewing these from the ISAR-5 drive bulkhead and place to one side.
- RM-8 Inspect all components for obvious sign of wear or stress.
- RM-9 Undo the 5 cap screws holding the drive assembly in place.
- RM-10 Disconnect the Shaft encoder RJ-11 jack and also the scan motor power cable.
- RM-11 Use a 2mm hex key to loosen the shaft coupling that connects the drive motor to the encoder. Loosen the coupling using only the grub screw furthest away from the drive motor so that the coupling stays connected to the drive motor shaft.
- RM-12 Remove the drive motor housing assembly from the ISAR.
- RM-13 The US-Digital encoder has an O-ring on the front face and will require delicate manoeuvring to free this seal. Alternatively, the ISAR main bulkhead may be split and the entire scan drum assembly will be removed with the drive bulkhead. 🌀* ***If you choose this latter option, be extremely careful to ensure that nothing falls onto the ISAR ZnSe window as this will then need replacing!!***
- RM-14 Gently slide out the scan drive assembly. 🌀* ***When the scan drive assembly is removed from the ISAR, take care not to deposit anything into the blackbody apertures or in the labyrinth leading to the ZnSe window !***
- RM-15 You should now have access to the scan drive sub assembly. Take this opportunity to examine the blackbody apertures for contamination as best you can. Also examine the ZnSe window using a small flashlight to clearly see the window. Examine the scan drum main bearing for wear. Examine the shaft coupling between the shaft encoder and the encoder drive motor. Examine all components for corrosion and wear. Finally examine the scan drum bush seals and compression springs for wear and damage. Replace as required.
- RM-16 Locate the scan drum retaining screw on the side of the scan drum and remove.
- RM-17 The outer scan drum should now slide off. 🌀* ***Take care with the 2 small drive keys locating the scan drum and mirror mounting !***
- RM-18 You should now have access to the scan drum mirror. Inspect the mirror and record your results in the instrument log.
- RM-19 Unscrew the 4 countersunk screws holding the scan mirror retaining plate in place.
- RM-20 Remove the scan mirror retaining plate.
- RM-21 Remove the scan mirror.
- RM-22 The mirror may be cleaned using a wash of distilled water followed by a wash in acetone. If the mirror is scratched or dirty following this procedure, discard and replace with part IS5-SOC-004.
- RM-23 🌀* ***Replace the mirror taking great care not to touch the surface of the mirror.***

- RM-24 Replace the mirror retaining plate and 4 countersunk screws. You may use a small amount of threadlock to secure the screws in place.
- RM-25 Replace the scan drum using the keys.
- RM-26 Replace the scan drum retaining bolt using a small amount of threadlock as required.
- RM-27 You are now ready to replace the scan drum subassembly back into the ISAR instrument. Prior to inserting the US-Digital shaft encoder, check the O-ring on the encoder faceplate for wear and grease it with silicon grease.
- RM-28 Replace the scan drive retaining bolts and tighten.
- RM-29 Replace the 6 retaining rods by screwing these back into the ISAR drive bulkhead.
- RM-30 Lightly grease the drive bulkhead O-ring seal. Inspect the O-ring on the main body and replace with part IS5-SOC-047 as required.
- RM-31 Replace the outer casing.
- RM-32 Lightly grease the end cap O-ring seal. Replace with part IS5-SOC-047 as required.
- RM-33 Replace the end cap and press firmly home ensuring that there is sufficient thread exposed on the end cap retaining rods to start the dome nuts when the dowty washers are in place.
- RM-34 Add a small amount of silicone grease to each retaining rod end.
- RM-35 Inspect the dowty washers for damage and replace with part IS5-SOC-040 as necessary.
- RM-36 Inspect the Dome nuts for damage and replace with part IS5-SOC-037 as required.
- RM-37 Carefully tighten the dome nuts to ensure an even seating of the end cap.
- RM-38 Enter details of the replacement components into the instrument maintenance record spreadsheet (ISAR-5C-instrument-???.xls) making sure to quote all serial and batch numbers as required.

9.3 Reconfiguration of US-DIGITAL shaft encoder Procedure (SE)

Follow the instructions in the US-digital manual provided on the ISAR-5C CD-ROM. Settings should be for 3600 increments to provide an encoder resolution of 0.1°. The reference position should be set and recorded. This value should be entered into the isarconf.icf file.

9.3.1 Equipment and supplies

For this procedure you will need the following tools:

- M6 socket nut spinner
- U.S Digital AD2-B adaptor
- U.S Digital 9v dc power supply
- PC with com port and terminal
- U.S Digital software.

You may need the following replacement ISAR-5C components and supplies:

- 2 x O-ring seal for outer casing (Part#: IS5-SOC-046)
- 6 x Dowty washers (Part#: IS5-SOC-040)
- 6 x M6 Dome nuts (Part#: IS5-SOC-037)
- Silicone grease

9.3.2 Procedure SE

Follow these steps to reconfigure the U.S Digital shaft encoder:

- SE-1 Make sure the ISAR shutter is in the open position before commencing this procedure.
- SE-2 Using the proto software, if possible set the scan drum aperture edge to just touch the back face of the ISAR-5C main body (an absolute angle of 355.5° assuming the shaft encoder zero is set at 0°).
- SE-3 Follow procedures RM-1 to RM-6 in order to gain access to the shaft encoder RJ45 plug.
- SE-4 Disconnect the ISAR RJ45 plug
- SE-5 Connect the A2D-B adaptor RJ45 plug to the ISAR shaft encoder.
- SE-6 Use the US-Digital software “SEI Explorer” to set the encoder for 3600 resolution (0.1° increment). Select the menu option found on the top left hand window pane showing the encoder response. Change each setting in turn. A2 Encoders should be set to:
 - A resolution of 14400 (0.025 deg resolution),
 - 9600 baud,
 - scale factor of 1 and no mode setting,
 - Assign address 0x0E (decimal 14) to the encoder to prohibit contention with other RS485 devices.
- SE-7 Use the “Get Factory Info” menu item to check the configuration.
- SE-8 It is necessary to set the zero position of the shaft encoder. This is achieved by the following steps:

- i. Move the scan drum (protonnn command E) so that the aperture hole lines up with the longer of the two face lines (the whole aperture hole must be visible).
- ii. This is now in the absolute position 4.5 degrees.
- iii. Rotate the scan drum to zero degrees (some of the aperture hole will now disappear).
- iv. Set the encoder with the SEI-Explorer software to zero.

SE-9 Store the zero position

SE-10 Lightly grease the drive bulkhead O-ring seal. Inspect the O-ring on the main body and replace with part IS5-SOC-047 as required.

SE-11 Replace the outer casing.

SE-12 Lightly grease the end cap O-ring seal. Replace with part IS5-SOC-047 as required.

SE-13 Replace the end cap and press firmly home ensuring that there is sufficient thread exposed on the end cap retaining rods to start the dome nuts when the dowty washers are in place.

SE-14 Add a small amount of silicone grease to each retaining rod end.

SE-15 Inspect the dowty washers for damage and replace with part IS5-SOC-040 as necessary.


SE-16 Inspect the Dome nuts for damage and replace with part IS5-SOC-037 as required.

SE-17 Carefully tighten the dome nuts to ensure an even seating of the end cap.

SE-18 Enter details of the replacement components into the instrument maintenance record spreadsheet (ISAR-5C-instrument-???.xls) making sure to quote all serial and batch numbers as required.

9.4 Replacement of ISAR-5C ZnSe window (Procedure RW)

This procedure describes the steps required to replace the ZnSe window. While this is a fairly simple operation, it requires that the ISAR-5C is disassembled as the window is situated deep within the ISAR-5C instrument. Be sure to allocate sufficient space on the workbench for this procedure preferably in a clean dust free laboratory to avoid contamination of the optical components. When the procedure is completed ***be sure to revise the instrument maintenance record spreadsheet (ISAR-5C-instrument-???.xls) !!***

 **Zinc selenide (ZnSe)** is toxic and we recommend that you consult your local health and safety guidelines when handling this material. It has a very brittle structure and can be easily broken. Furthermore, the antireflection coatings deposited onto the window may easily scratch. For all these reasons, please use extreme care when handling the ISAR-5C window, using fresh rubber gloves in a clean room.

9.4.1 Equipment and supplies

For this procedure you will need the following tools:


- 8 mm hex spanner
- 4 mm hex spanner
- 2.5 mm hex spanner
- M6 socket nut spinner

You may need the following replacement ISAR-5C components and supplies:

- 1 x Replacemet ZnSE window (Part#: IS5-SOC-012)
- 2 x O-ring seal for outer casing (Part#: IS5-SOC-046)
- 2 x O-ring seals for ZnSe retaining plate (Part#: IS5-SOC-047)
- 4 x 4mm o-ring (Part#: IS5-SOC-048)
- 6 x Dowty washers (Part#: IS5-SOC-040)
- 6 x M6 Dome nuts (Part#: IS5-SOC-037)
- Silicone grease
- Thermal grease
- Rubber gloves
- Acetone
- Lint free cloth

9.4.2 Procedure RW

Follow these steps to Replace the ISAR-5C ZnSe Window:

- RW-1. Place the ISAR instrument standing vertically with the main body at the top (the long section).
- RW-2. Open the ISAR main body end cap by undoing the 6 dome nuts holding it in place. Remove the dome nuts and the Dowty washers beneath.
- RW-3. Using the tool provided, release the end cap from the main body. This may be a particularly tight fit and require patience.  **do not use excessive force! Be careful not to strain any wires when removing the end cap !** Gently ease the cap away and disconnect all wires attached to the plugs on the end cap using the inline plugs provided. Disconnect the GPS antenna from the GPS board and the earth wire from the case.

- RW-4. Remove the end cap and inspect the O-ring seal. Replace with part IS5-SOC-047 as required.
- RW-5. Remove the outer casing. Inspect the O-ring on the main body and replace with part IS5-SOC-047 as required.
- RW-6. Remove the 6 retaining rods now visible by unscrewing these from the ISAR-5 main bulkhead and place to one side. ★ *Be careful not to damage the window thermistor cable which should be looped around one of the retaining rods !*
- RW-7. Remove the 2.5 mm cap screw holding the window thermistor cable retainer taking care not to damage the sensor cable.
- RW-8. Be especially careful of the window thermistor that can now be removed from its mount. ★ *Take great care not to contaminate the area with old thermal grease during this operation !* Wrap the thermistor in protective foam as any physical shock or damage may render the calibration void.
- RW-9. In order to gain proper access to the ZnSe window, it is necessary to remove the entire optical bench from the ISAR-5C main bulkhead. Undo and remove the 4 cap screws holding the optical bench to the main bulkhead. The optical bench should stay in place as it is maintained by two precision dowel pins.
- RW-10. Prepare a safe and secure area to place the optical bench when removed. Carefully remove the optical bench (with the KT15 and electronics in place) from the main bulkhead. A gentle rocking motion normally releases the dowels. ★ *Be careful not to damage any cables by pulling or stressing them when removing the optical bench.*
- RW-11. You should now have a clear view of the ZnSe window which is held in place by 4 M4 cap screws and a black retaining plate. Inspect the area for moisture/salt contamination and note any contamination. Contamination may indicate a broken seal on the window mounting plate.
- RW-12. Remove the 4 M4 cap screws and inspect the O-ring seals. Replace with part IS5-SOC-048 as required.
- RW-13. Remove the ZnSe window retaining plate and inspect the area for moisture/salt contamination.
- RW-14. Remove the O-ring seal above the window and discard.
- RW-15. Thoroughly clean the retaining plate with alcohol and set to one side.
- RW-16. Carefully remove the ZnSe window. It might be easier to turn the ISAR-5C upside down and tip the window out into your gloved hand rather than to contaminate the window.
- RW-17. Inspect the ZnSe window for corrosion, scratches or damage. If excessive corrosion or damage is evident discard the window and replace with part IS5-SOC-012 as required. The window may be cleaned using distilled water and a soft lint free cloth followed by a wash in alcohol.
- RW-18. Inspect the ZnSe window mount plate for corrosion. It should not be necessary to remove this component if no obvious contamination is present.

- RW-19. Thoroughly clean the ZnSe seating area with alcohol. ★ *Be careful not to spill or drop anything onto the gold scan mirror which is beneath the ZnSe window mounting !!*
- RW-20. If required, replace the thermal grease in the ZnSe window thermistor mounting and wipe off excess grease.
- RW-21. Replace the ZnSe window being careful to ★ *avoid touching the face of the component.. Use rubber gloves at all times.*
- RW-22. Lightly grease a new ZnSe O-ring seal (part IS5-SOC-047) and ★ *carefully lay this onto the face of the ZnSe window taking care not to contaminate the window surface.*
- RW-23. Replace the ZnSe window retaining plate.
- RW-24. Replace M4 cap screws and new O-ring washers ★ *taking care to tighten each screw slowly and evenly to prevent excessive strain on the window and possible cracking.*
- RW-25. Relocate the ZnSe window thermistor into the thermal grease filled seating.
- RW-26. Replace the M2.5 ZnSe window thermistor cable retainer making sure that the cable is clear of the end cap retaining rod tapped hole.
- RW-27. 🌟* *Inspect the new window – does everything look ok ?*
- RW-28. Carefully replace the optical bench on the location dowels.
- RW-29. Replace the 4 M8 retaining cap screws and tighten slowly to ensure an even seating of the optical bench. 🌟* *Inspect the seating- is it ok ?*
- RW-30. Re-fit 6 end plate retaining rods taking care to ensure that the window thermistor cable is suitably wrapped around the retaining rod.
- RW-31. Lightly grease the O-ring seals for the body section on both the main bulkheads.
- RW-32. Ensure that all electronics cables and plugs are centred and accessible so that you can access them after the main body case is replaced.
- RW-33. Lightly grease the main body o-ring seal using silicone grease.
- RW-34. Replace the main body case.
- RW-35. Reconnect all plugs, the earth wire and GPS unit.
- RW-36. Lightly grease the end cap O-ring seal using silicone grease.
- RW-37. Replace the end cap and press firmly home ensuring that there is sufficient thread exposed on the end cap retaining rods to start the dome nuts when the dowty washers are in place.
- RW-38. Add a small amount of silicone grease to each retaining rod end.
- RW-39. Inspect the dowty washers for damage and replace with part IS5-SOC-040 as necessary.
- RW-40. Inspect the Dome nuts for damage and replace with part IS5-SOC-037 as required.

- RW-41. Carefully tighten the dome nuts to ensure an even seating of the end cap.
- RW-42. Enter details of the replacement components into the instrument maintenance record spreadsheet (ISAR-5C-instrument-???.xls) making sure to quote all serial and batch numbers as required.

9.5 Configuration of the PNI-TCM2 (procedure PNI)

The PNI TCM-2 compass module must be correctly configured before using the device in an ISAR instrument. The configuration of a PNI0-TCM2 module is performed using the Proto software system that must be run from the ISAR flashcard. The Proto option '**p**' under the ENGINEERING MENU (select option '>') must be used to send configuration commands to the PNI instrument. These are then stored on the PNI TCM-2 EEPROM. The output configuration of the PNI-TCM2 can be checked at any time using the Proto command '**p**'.

9.5.1 Equipment and supplies

- An ISAR instrument with a PNI-TCM2 device correctly installed
- A version of the Proto software
- PNI-TCM2 reference manual

9.5.2 Procedure PNI

- PNI-1 Stop the ISAOROS operational code after turning the ISAR on. You should be returned to the TOM8> prompt.
- PNI-2 At the TOM8> prompt type PROTOxxx.RUN (where xxx) refers to the software version number of the Proto code) to run the Proto software.
- PNI-3 Using option '**p**' from the engineering menu (option '>'), clear the on-board calibration data by sending the command: **cc** <enter>
- PNI-4 Disable fast sampling of the TCM-2 by sending the command: **fast=d** <enter>
- PNI-5 Set the PNI-TCM2 clock rate using the command: **clock=10.0** <enter>
- PNI-6 Set the PNI-TCM2 clip rate using the command: **clip=40** <enter>
- PNI-7 Set the PNI-TCM2 baud rate to 9600 using the command: **baud=5** <enter>
- PNI-8 Set the PNI-TCM2 temperature units to centigrade using the command: **ut=c** <enter>
- PNI-9 Set the PNI-TCM2 compass units to 360° full circle using the command: **uc=d** <enter>
- PNI-10 Set the PNI-TCM2 inclinometer units to 360° full circle using the command: **ui=d** <enter>
- PNI-11 Set the PNI-TCM2 RS232 word format to standard TCM2 output word using the command: **sdo=t** <enter>
- PNI-12 Enable the PNI-TCM2 compass data for output word using the command: **ec=e** <enter>
- PNI-13 Enable the PNI-TCM2 pitch data for output word using the command: **ep=e** <enter>
- PNI-14 Enable the PNI-TCM2 roll data for output word using the command: **er=e** <enter>
- PNI-15 Enable the PNI-TCM2 temperature data for output word using the command: **et=e** <enter>

PNI-16 Disable the PNI-TCM2 magnetometer data for output word using the command: **em=d** <enter>

PNI-17 Disable the PNI-TCM2 magnetic distortion data for output word using the command: **ed=d** <enter>

PNI-18 Disable the PNI-TCM2 analogue output mode using the command: **sao=d** <enter>

PNI-19 Select uncorrected magnetometer readings using the command: **ma=u** <enter>

PNI-20 Save the settings to the PNI-TCM2 eeprom using the command: **save** <enter>

The PNI-TCM2 device should now be configured correctly for the ISAR instrument. Use the Proto command 'p' to read a data packet from the PNI-TCM2. It should return a record identical in format to

```
$C149.3P-1.1R0.0T29.0*0C
```

9.6 Configuration of Lassen SK-II GPS card (procedure GPS)

The Lassen SK-II GPS unit used within an ISAR is configured for a default output other than a \$GPGGA NMEA string. This procedure describes how to modify the Lassen SK-II on-board eeprom configuration settings to permit \$GPRMC, \$GPGLL and \$GPGGA NMEA output only.

9.6.1 Equipment and supplies

For this procedure you will need the following tools:

- GPS interface board
- Spanners
- Desktop Power supply
- TSIPCHAT v1.50(7.68a) software
- PC computer

You may need the following replacement ISAR-5C components and supplies:

- 1 x O-ring seal for outer casing (Part#: IS5-SOC-046)
- 6 x Dowty washers (Part#: IS5-SOC-040)
- 6 x M6 Dome nuts (Part#: IS5-SOC-037)
- Silicone grease
- Acetone

9.6.2 Procedure GPS

Follow these steps to configure the GPS card.

GPS-1 Install TSIPCHAT configuration software onto PC

GPS-2 Remove ISAR end cap

GPS-3 Locate GPS unit within ISAR (small PCB to the left of the electronics package – you can see a gold connector that is wired to the center BNC socket on the ISAR end cap)

- GPS-4 Disconnect the GPS plug carefully noting connection direction (remove outer casing if this is difficult). Red and black cables indicate power supply connections.
- GPS-5 Connect the Red and black cables from the interface board to 5V d.c on a PSU.
- GPS-6 Attach interface board plug to the GPS unit making sure that the red and black cables are located properly. Attach the yellow D-type connector to the PC COM-1 port.
- GPS-7 Start the TSIPCHAT program in a DOS window using the command `tsipchat -c1` (assuming you are using COM1). You should see lots of numbers scrolling up the screen.
- GPS-8 Configure the output options of the GPS card. Use '?' to access the TSIPCHAT menu and select option 'O' Set I/O options. Use the space bar to select the Set option and press enter. Use the space bar to select 'no' to the 'Turn on GPS Spkt 8F-20?' request (this allows you to manually set the parameters up).
- Set LLA output to on
 - Set WGS-84 Altitude output to on
 - Set WGS-84 Altitude input to on
 - Set to Double precision output
 - Set ENU leococity output to on
 - Set Timetags in UTC (not GPS)
 - Set Signal strength to AMU
 - Set everything else to off
- GPS-9 From the main menu (option ?), configure the NMEA output setup by selecting option 'q'. Choose the Set (rather than Request) option.
- Set the NMEA interval to 1 (1 second)
 - Turn on GGA, GLL and RMC output and turn all other options off.
- GPS-10 Return to the main menu and use the command '%' TSIP command string to save the configuration to the GPS eeprom. Enter the string 0x8E-26, hit return and then press '=' to access the submenu options. Select submenu option 's' to save the configuration to the GPS eeprom. If all is well you should get a 'SEE write successful' message. This is described in the Lassen SK-II system developers manual in section 3.7.3 in more detail if you run into problems.
- GPS-11 Turn off the power supply to the GPS card for a minimum of 2 minutes. Close the TSIPCHAT software and DOS window.
- GPS-12 Disconnect the yellow D-type plug from the PC COM1 port and connect the orange D-Type to COM1. This port provides an ASCII output that can be viewed using hyperterm (set to Baud 4800, no handshake). Start up hyperterm in this configuration and power up the GPS card. Initially you may only see GPGGA strings as the GPS unit locates satellites from a warm boot. Once these are located you should be able to see GPRMC, GPGLL and GPGGA strings.
- GPS-13 Power down the GPS card and disconnect the interface from GPS unit, PSU and PC
- GPS-14 Reconnect ISAR internal plug noting direction of plug (red and black wires)
- GPS-15 Verify GPS output by booting ISAR and noting the output
- GPS-16 Replace ISAR end cap.

9.7 Optical alignment (procedure OI)

This procedure describes how to verify that the KT15 is optically aligned within the ISAR instrument. The design of the ISAR instrument is such that full optical alignment can be performed without the need for an optical bench or external target sighting system.

9.7.1 Equipment and supplies

For this procedure you will need the following tools:

- 8 mm hex spanner
- 4 mm hex spanner
- 2.5 mm hex spanner
- M6 socket nut spanner
- Sighting laser⁴
- Sighting laser mount
- ISAR optical alignment tool
- ISAR eccentric washer spanner tool

You may need the following replacement ISAR-5C components and supplies:

- 1 x Replacemet ZnSe window (Part#: IS5-SOC-012)
- 2 x O-ring seal for outer casing (Part#: IS5-SOC-046)
- 2 x O-ring seals for ZnSe retaining plate (Part#: IS5-SOC-047)
- 4 x 4mm o-ring (Part#: IS5-SOC-048)
- 6 x Dowty washers (Part#: IS5-SOC-040)
- 6 x M6 Dome nuts (Part#: IS5-SOC-037)
- Silicone grease
- Thermal grease
- Rubber gloves
- Acetone
- Lint free cloth

9.7.2 Procedure OI

Follow these steps to optically align the KT15 radiometer head

- OI-1 Remove end plates.
- OI-2 Remove outer cases.
- OI-3 Remove encoder/scan drum assembly.
- OI-4 Remove optical bench retaining bolts and attach the optical bench jacking blocks. Then use the jacking screws to remove the optical bench. Make sure that you alternate between the two jacking screws to keep the optical bench parallel with the bulkhead.

⁴ Please read all safety advisory notes included with the laser system and ensure that your laboratory conforms to all safety standards when using laser light devices. Note that laser light may damage your eyes and appropriate eyewear protection and safety procedures should be followed at all times. It is your responsibility to protect yourself and your colleagues from the hazards of laser light injury!

- OI-5 Remove ZnSe window.
- OI-6 Inspect everything and replace as necessary.
- OI-7 Remove electronics from optical bench (do not disconnect the electronics)
- OI-8 Loosen KT15 mounting plate retaining bolts and slide KT15 mounting plate to rearmost position
- OI-9 Attach Laser and laser mount to KT15 lens.
- OI-10 Replace optical bench.
- OI-11 Slide KT15 back into operational position and finger tighten retaining bolts. Make sure that eccentrics are aligned so that the KT15 is approximately parallel with the optical bench axis.
- OI-12 Turn ISAR so that KT15 is standing vertically up (i.e.: the electronics side closest to the table, motor side on top).
- OI-13 Attach the optical alignment tool (drop into encoder seating)
- OI-14 Turn laser on and adjust KT15 position using eccentric spanner to have the strongest laser output. Turn the alignment tool to establish the best location. Tighten the KT15 into position.
- OI-15 Replace scan drum assembly.
- OI-16 Attach paper with centreline drawn between the ISAR main body split.
- OI-17 Turn laser on and operate scan drum. Laser light should follow the centreline drawn on paper. Use the KT15 eccentrics to make sure this is the case.
- OI-18 Remove optical bench and laser.
- OI-19 Replace ZnSe window.
- OI-20 Replace optical bench – tape up the KT15 adjustments with a note indicating date and person who made the OI.
- OI-21 Replace electronics.
- OI-22 Replace end caps.

10 Troubleshooting

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

10.1 Software

Check the Isarconf.icf file. This is normally the cause of most problems. See section 7.3

10.2 Hardware

10.2.1 Modification history

The designs of the ISAR electronics boards have been revised as follows:

- Revision A: Prototype board was based on the Preconic Bay data logger interface (BNL project).
- Revision B: This board was built for ISAR 1 following extensive testing of Rev. 1. Main changes included removal of redundant devices (real-time clock, several A/D buffers). Solid state devices specific to ISAR were included on the board, added a board thermistor, power supplies for ISAR devices, LED indicators for switched power, US-DIGITAL encoder interface, scan and door motor controller, and BB interface circuit.
- Revision C: This board eliminated the TT8 squishy Bus system with minor mods to various systems.
- Revision D: Strictly cosmetic changes but functionally, this board is identical to Revision C
- Revision E: (Current revision, includes Thermistor ports to the 12 bit A/D,

The revision history of the ISAR mechanical system design is as follows:

- Revision A: Basic design built and modified during initial build.
- Revision B: Minor modifications to the general design mainly to relocate various bolts on the main bulkhead section, reworking of the ZnSe seating, modifications to the optical bench fasteners, new PNI mounting bracket, new electronics board mounting plate, new end caps.
- Revision C: Tidied up all outstanding errors on drawings and revised the main bulkhead section, relocation of magnets in shutter, additional clearance for shutter, relocated all incorrect holes for main bulkhead clamping.
- Revision D: Added thermistors at BB aperture.

10.2.2 Electronics board schematic diagrams

10.2.3 12 bit A/D Thermistor locations (BB aperture and on KT15 case)

Four thermistors are attached to the TT8 12 bit A/D channels. Three of these are used to monitor the temperature of the blackbody apertures and one is used as an external monitor for the temperature of the Kt15 case. The aperture thermistors are located according to Figure 10-1

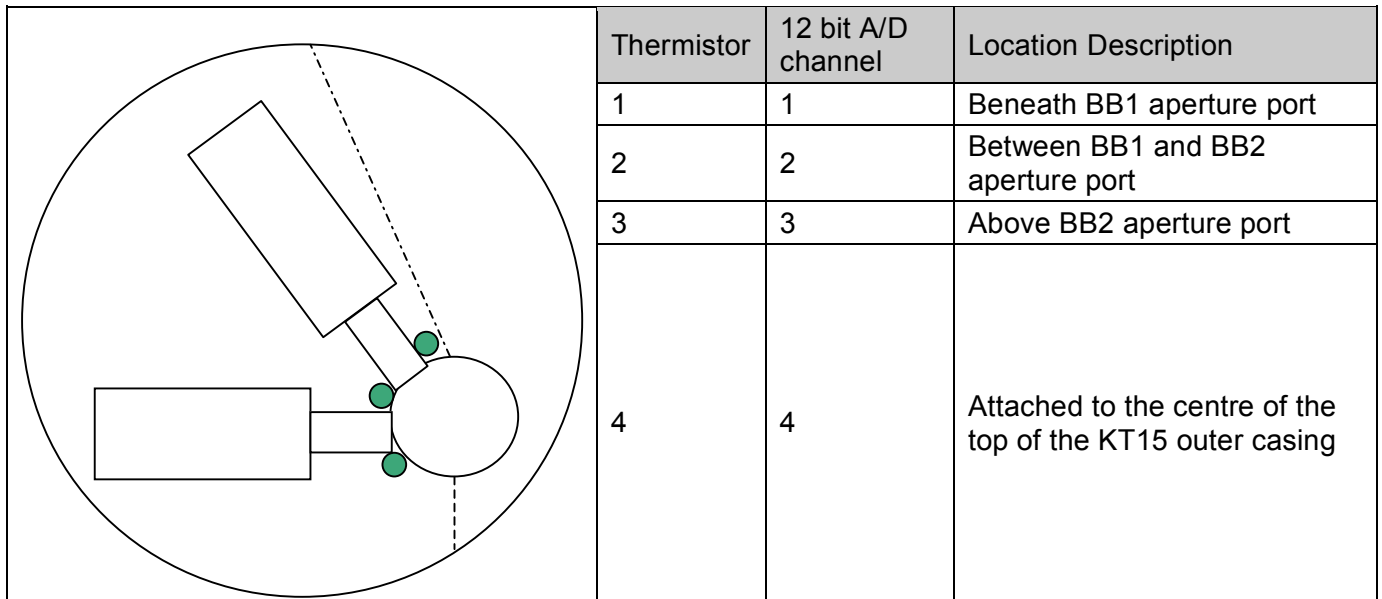


Figure 10-1. Location of Aperture thermistors and 12 bit A/D channel assignments

Appendix A: Example isarconf.icf file (isaros-v7.19 11/10/2007)

The following provides an example isarconf.icf 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 isaros v7.19 code base
##### General format: #=comment followed by 1 line data
##### DO NOT DELETE ANY LINES FROM THIS FILE
#
#####
##### 2007-10-11: W Wimmer Version 7.19, Revision 1
#
##### Contact information #####
#
#### Title for this deployment/configuration stating purpose of this isarconf file (str[255])
icf file for ISAR-05 valid for isaros-v7.19 code base for BB calibration runs
#### ICF author name, e-mail and telephone number (str[255])
W Wimmer (w.wimmer@soton.ac.uk +44 2380 597654)
#### Last Edit date of this icf file yyyy-mm-dd (str[15])
2007-10-11
#
##### General instrument configuration #####
#
#### ISAR-5C serial number (int)
5
#### Date and details of last ISAR-5C instrument calibration date (str[255])
Pending
#### USER FLAGS:0=log data to flashcard,1=compute SSTskin 2=Diagnostics at startup, 3=print raw PNI data
4=print raw GPS data, 5=print $IS5MR data, 6=print $I5CAL record, 7=XTEMP, 8=roll/pitch, 9=freezing,
10 ORG warming up on/off (int[20])
1,1,1,1,1,1,1,0,0,0,1,0,0,0,0,0,0,0,0,0
#### Number of cycles to wait after rain event has finished (time is ~n*2 secs. Lab=60 Field= ~350)
(int)
60
#### 10 scan drum measurement angles -1 if not used (float, spearator=',') BB1,BB2,sea,sky...
280.0,325.0,25.0,90.0,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### 10 Number of samples for each target angle view. -1 if not used (int, spearator=',')
30,30,5,30,-1,-1,-1,-1,-1,-1
#### SST real time calculation setup (double): 0=seaview drumangle index,1=skyview drumangle
index,2=seawater emissivity,3=RMR x x correction factor, 4=Vref (0 uses measured Vref), 5=Rref, 6=internal
bb emissivity,7=SelfHeating correction on/off,8-9=empty
3,2,1.0,1.0,0.0,10000.0,0.9993,0.0,-1.0,-1.0
#### Heated (Active) blackbody (1 or 2)
2
#### Input supply linear calibration coefficeints y=mx+c [0]=c,[1]=x
0.311863,4.03453e-3
#
##### External RS485 configuration #####
#
#### 8 External RS485 device description (str[8][80] separate fields with ',', Default=NoDevice)
NoDevice,NoDevice,NoDevice,NoDevice,NoDevice,NoDevice,NoDevice,NoDevice
#### 8 External RS485 device address (0x03 and 0x0E are reserved) (int[8], default=0)
0,0,0,0,0,0,0,0
#### 8 External RS485 device data read command (str[8][30] separate fields with ',', Default=NoCommand)
NoCommand,NoCommand,NoCommand,NoCommand,NoCommand,NoCommand,NoCommand,NoCommand
#### 8 External RS485 device bitdelay (int[8] separated by ',' Default=-1)
-1,-1,-1,-1,-1,-1,-1,-1
#
##### PNI compass configuration #####
#
#### PNI sensor pitch warning limit (deg) (float)
2.0
#### PNI sensor roll warning limit (deg) (float)
2.0
#### PNI compass serial number (str[80])
11676_(v2.82)
#
##### SCTI ORG configuration #####
#
#### SCTI Optical rain gauge serial number (str[80])
02020036
#### SCTI Optical rain gauge description (str[128])
Model ORG-815-DA standard configuration.
```

```

#### Optical rain guage rain mV threshold below which shutter is closed (float). Lab=1.0, Field= ~0.062
1.0
#### Optical rain guage rain mV standard deviation above which shutter is closed (float). Lab=1.0,
Field= ~0.0015
1.0
#
##### A2 Encoder configuration #####
#
#### US-DIGITAL A2 Encoder serial number (str[80])
70101M
#### A2 encoder reference position (float,deg)
0.0
#### A2 encoder park angle (normally over lower blackbody) (float,deg)
280.0
#
##### Optical component configuration #####
#
#### ISAR-5C mirror serial number (str[80])
LBR-SNICU24-3-00/04 (2007-10-11)
#### ISAR-5C window serial number (str[80])
CRYSTAN-ZNSE bbar batch 24827
#
##### Motor configuration #####
#
#### ISAR-5C scan drum drive motor and gearbox serial number (str[80])
MAXON-A-Max 110926 Installed on: 2007-10-01
#### ISAR-5C shutter drive motor and gearbox serial number (str[80])
MAXON-A-Max 110926 Installed on: 2007-10-01
#
##### GPS configuration #####
#
#### Trimble GPS board serial number (str[80])
29467-00 (Lassen SKII)
#
##### KT15 configuration DON'T Touch !#####
#
#### KT15.85D Serial number (int)
8115
#### Date and details of KT15.85D last calibration (str[255])
2001-27-11 (Not used until 2003-05-05), Polynomials for R2T & T2R: TJ Nightingale 2003-06-04
#### KT15 emissivity setting command (0.001 -> 1.000) (str[15])
EPS 1.000
#### KT15 response setting command (0.05, 0.1, 0.3, 1 3 or 10 seconds) (str[15])
RESP 1.0
#### KT15 analog output setting command (Do you know what you are doing ?) (str[30])
ANALOG -100.0 50.0 C 3
#### KT15 serial interface setting (Do you know what you are doing ?) (str[20])
COM 96 8 1 n
#### KT15 Temperature to Radiance coefficients based on kt15 filter response (-1 not used) (double[9])
-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])
273.15973e0,54.529628e0,10.634341e0,2.0172007e0,3.6480705e-1,5.7776974e-2,6.5293295e-3,3.5814663e-4,-1.0
#
##### Electronics configuration DON't touch !#####
#
#### Serial/batch number for BNLI SAR board (char[80]) e.g.,BNL/Jan2002/RevC/001
BNL/Jul2002/RevC/001
#### Serial number of TT8 computer (int) e.g., 505416
505416
#### Serial number of Persistor borad (int) e.g., 1246
1264
#### Serial number of CFCard (char[10]) e.g., SOC001
SOC001
#### ADAM 4017 A/D serial number
ZC70029
#
##### Black body #1 configuration #####
#
#### BB1 serial number (int)
9
#### BB1 description (str[128])
ISAR5C BB new for ISAR-005 - build 21-09-2007
#### BB1 thermistor 1 serial number (str[80])
ISAR-TH20-11032
#### BB1 Thermistor 1 description (str[128])
YSI NASA grade 46041 0.05K intercahngable thermistor with standard YSI calibration

```

```

#### BB1 Thermistor 1 calibration coefficients: Range 268.16 ->338.16K, -1.0 not used(double[10])
1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### BB1 thermistor 2 serial number (str[80])
ISAR-TH21-11032
#### BB1 Thermistor 2 description (str[128])
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])
1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### BB1 thermistor 3 serial number (str[80])
ISAR-TH22-11032
#### BB1 Thermistor 3 description (str[128])
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])
1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#
##### Black body #2 configuration #####
#
#### BB2 serial number (int)
10
#### BB2 description (str[128])
ISAR5C BB new for ISAR-005 - build 21-09-2007
#### BB2 thermistor 1 serial number (str[80])
ISAR-TH23-11032
#### BB2 Thermistor 1 description (str[128])
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])
1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### BB2 thermistor 2 serial number (str[80])
ISAR-TH24-11032
#### BB2 Thermistor 2 description (str[128])
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])
1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### BB2 thermistor 3 serial number (str[80])
ISAR-TH25-11032
#### BB2 Thermistor 3 description (str[128])
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])
1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#
##### Instrument Thermistor configuration #####
#
#### Window thermistor serial number (str[80])
ISAR-TH26-11032
#### Window thermistor description (str[128])
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])
1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### TT8 thermistor serial number (str[80])
Off the shelf
#### TT8 thermistor description (str[128])
Thermometrics RL1005 (See thermistor_RL1005.pdf)
#### TT8 thermistor calibration coefficients: Range 273.16K->323.16, -1.0 not used(double[10])
3.3540172e-3,2.5027462e-4,2.4300527e-6,-7.2909526e-8,-1,-1,-1,-1,-1,-1
#### Channel A thermistor serial number (str[80])
ISAR-TH27-11032
#### Channel A thermistor description (str[128])
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])
1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### Channel B thermistor serial number (str[80])
ISAR-TH28-11032
#### Channel B thermistor description (str[128])
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])
1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### Channel C thermistor serial number (str[80])
ISAR-TH29-11032
#### Channel C thermistor description (str[128])
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])
1.0271173e-3, 2.3947051e-4, 1.5532990e-7,-1.0,-1.0,-1.0,-1.0,-1.0,-1.0
#### Channel D thermistor serial number (str[80])
ISAR-TH30-11032
#### Channel D thermistor description (str[128])
Channel D; YSI NASA grade 46041 0.05K interchangeable thermistor with standard YSI calibration

```

```
#### Channel D thermistor
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 (CROSSCUT for Windows/DOS – Note that the Windows version of CROSSCUT can not upload ASCII files., Minicom for Linux) which 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.: Ultraedit for Windows or kate/gedit for Linux)
- c. CROSSCUT software (Windows or DOS version) to upload new isaros software.

Appendix C: ISAR FAQ

How do I close the ISAR shutter?

The ISAR shutter can be opened / closed via the proto118 software. The command for opening the shutter is **d** and for closing is **D**.

How do I get to the PICODOS prompt?

First you have to shut down the isaros (software which runs after the instrument is powered up) by pressing **SHIFT Q** twice. Then you get a TOM8> prompt where you have to enter **g 2bcf8** and press **ENTER**. Now you should have a PICODOS> prompt on your terminal.

How do I start the PROTO118 software?

The proto118 software (see chapter 6.2) is started after the ISAROS is shut down (pressing SHIFT Q twice in a HyperTerminal to shut the ISAROS down). After the ISAROS has stopped a TOM8> prompt appears and by typing **g 2bcf8** you will get to the PICODOS prompt. Here you type **proto117** to start the PROTO118 software and then **?** for help or the required command (see Table 6.1.1)

How can I download a config file?

Go to the PICODOS prompt then set your terminal to capture the data printed in the terminal. Now enter **type isarconf.icf** in the terminal. Any excess lines (before the first # and after the last # have to be deleted, however do not change the layout of the config file!)

How can I upload a new config file?

You need the DOS version of crosscut (or another terminal program which can send an ASCII file). Go to the PICODOS prompt in your terminal software. The isarconf.icf file (use **dir** to see the content of your flash card) has to be deleted or renamed (**ren isarconf.icf <some file name (note 8.3⁵ file naming convention)>**). Then you type **capture isarconf.icf** at the PICODOS prompt which will start the capture process (Pressing ESC will stop the process – PICODOS prints **send BREAK** to end – ESC is the Break). Now you have to upload the prepared isarconf.icf file with your terminal software (send ASCII file) and once the file has been uploaded press ESC. Now you have a new isarconf.icf file ready for use. The file content can be checked by typing **type isarconf.icf** on the PICODOS prompt, which will print the content of the isarconf.icf file in the terminal window.

Note that the isarconf.icf file has to be saved in UNIX mode before it is uploaded.

How do I set up the config file?

Use a text editor to change the config file (e.g.: Ultraedit for Windows or kate/gedit for Linux). Make sure you do not change the format of the config file (i.e.: DO NOT delete or add any lines).

How can I download data from the ISAR?

⁵ 8.3 file naming convention means that the file name can have up to 8 characters in front of the . and up to 3 after.

Start the proto118 software and set up your terminal for capturing data. Then send the contents of the ISARDATA.DAT file by pressing \$.

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

Any text editor which can read UNIX style text files (e.g.: Ultraedit for Windows or kate/gedit for Linux)