Mission Control System for Solar AUV and Results of the Vehicle Long Time Operation Trials

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Abstract

Solar AUV (SAUV) [1,2] is a joint AUSI and IMTP project supported by the ONR NICOP program under grant number N00014-97-1-0155. The vehicle is designed for very long duration oceanographic data gathering missions. The vehicle surfaces during the day to recharge its onboard storage batteries. During SAUV operation the AUV periodically surfaces is to communicate with a remote operator via an RF modem or a satellite Oceanographic Data Link (ODL) [3]. The SAUV operational depth is up to 1000 meters and, since powered by solar energy, has unlimited endurance. The daily run of the vehicle in medium latitudes is 20-40 km depending on solar irradiance. A short description of the vehicle control system and the results of the long endurance sea trials are given in this paper.

SAUV Program Control System

The on-board control system consists of a commercially available SBC computer and set of micro controllers connected to each other via serial communication interface RS-485 (fig.1). The gray boxes in the diagram denote systems that are to be integrated in 2001.

The main task of on-board PC is to act as mission control. The mission consists of high-level command sequence. There are four groups of high-level commands (functions). The first group of functions completes AUV trajectory programming. The second group of functions manage the SAUV subsystems. The third group manage the onboard data required by the mission. They route acquired sensor data to appropriate mission commands. The functions, which initiate the complex mission tasks (tracking, inspecting, search), belong to the fourth group. Included in that group are functions to allow for event (signals) processing.

High level commands control specific features associated with the SAUV subsystems and devices. An additional command CHARGE() was introduced and intended for storage battery recharging from solar panels on the surface in the day time. High level mission commands create motion parameters and configure SAUV device operation. The parameters associated with these commands are loaded into a data structure named *common memory*. Communication driver software for the RS-485 channel allows transmission of the data from common memory to the micro controllers and writes the acquired data and state parameters from micro controllers into the common memory.

Other tasks performed by the on-board PC are vehicle position based on GPS and on-board reckoning systems data, sensed data storage, on-board device configuration and information exchange with the micro controllers and the operator computer. The on-board PC operates under control of the QNX distributed real time operating system.

The set of micro controllers implement the low level control functions for the storage battery recharging system, the main thruster drive system, the flap and rudder drive systems, and the various onboard sensors.

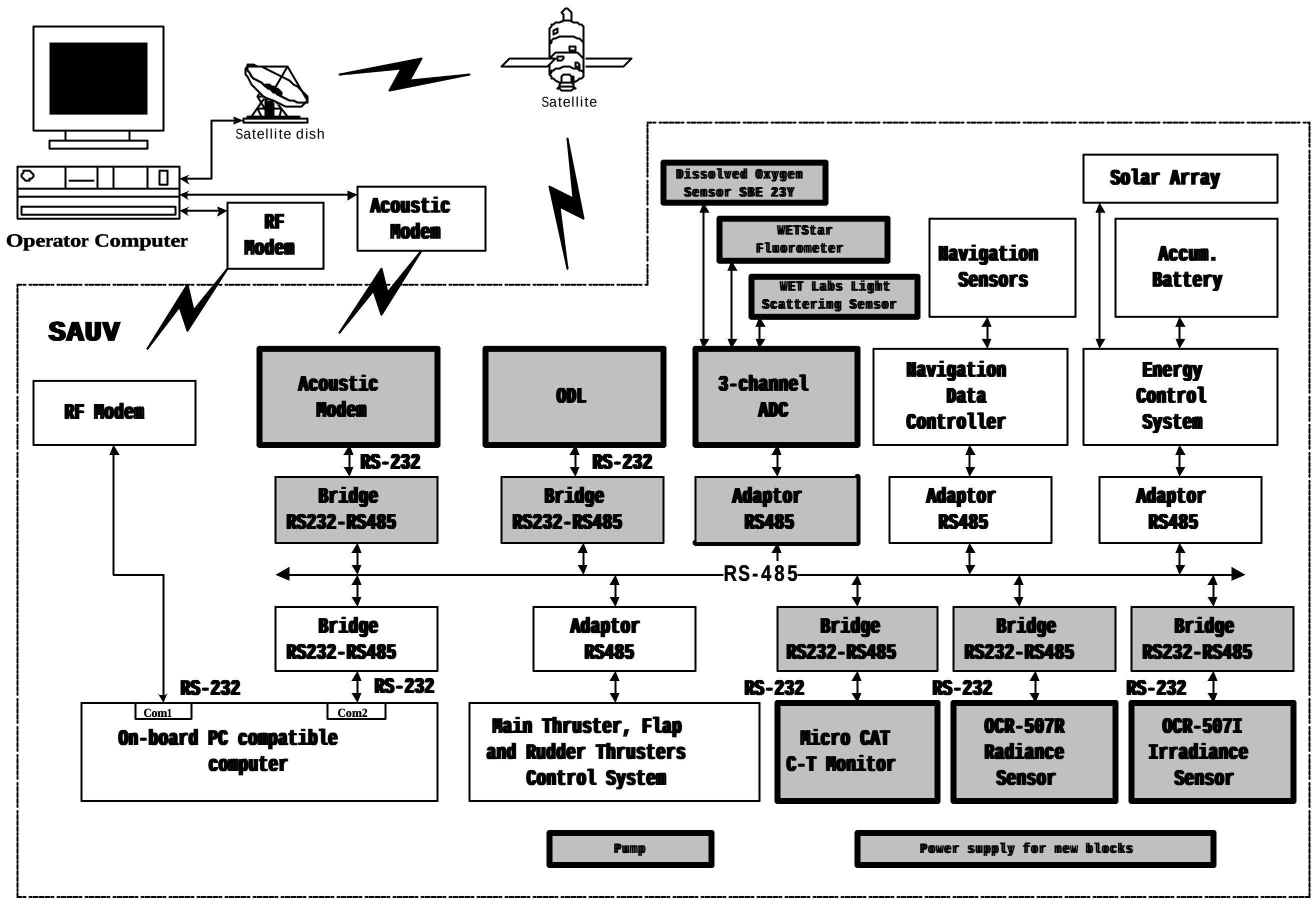

Fig.1. SAUV structural scheme of the on-board hardware.

The SAUV program control system includes an on-board program control system and operator console. Operator console is PC based that utilizes a multi-window graphical user interface /GUI/ operated in the Photon QNX environment. The GUI consists of basic and auxiliary windows. The basic windows include a mission preparation window, a mission execution control window, a current vehicle state parameters window and a map window that displays the SAUV trajectory.

Results of the Vehicle Long Endurance Trials

The main goal of the trials was to evaluate the long endurance SAUV operation. Location of operation – the Great Peter Bay near Vladivostok. The results of the M54 mission are described below. The algorithm for the M54 mission program is shown in fig.2a-c. Mission start – 16:16:06 05:10:2000. Mission finish – 08:39:15 07:10:2000. The day was sunny on 05:10:2000, on 06:10:2000 it was cloudy and on 07:10:2000 the day was rainy. The energy balance is illustrated in fig.3a-b. Voltage and current from batteries A and B are shown in fig.4 a-b and fig.5 a-b. The storage batteries A and B were connected in parallel (through diodes). Finally, the SAUV trajectory is displayed in fig.6. The total length of the mission transit was 32,152 meters. The mission execution was terminated because of exhausted batteries.

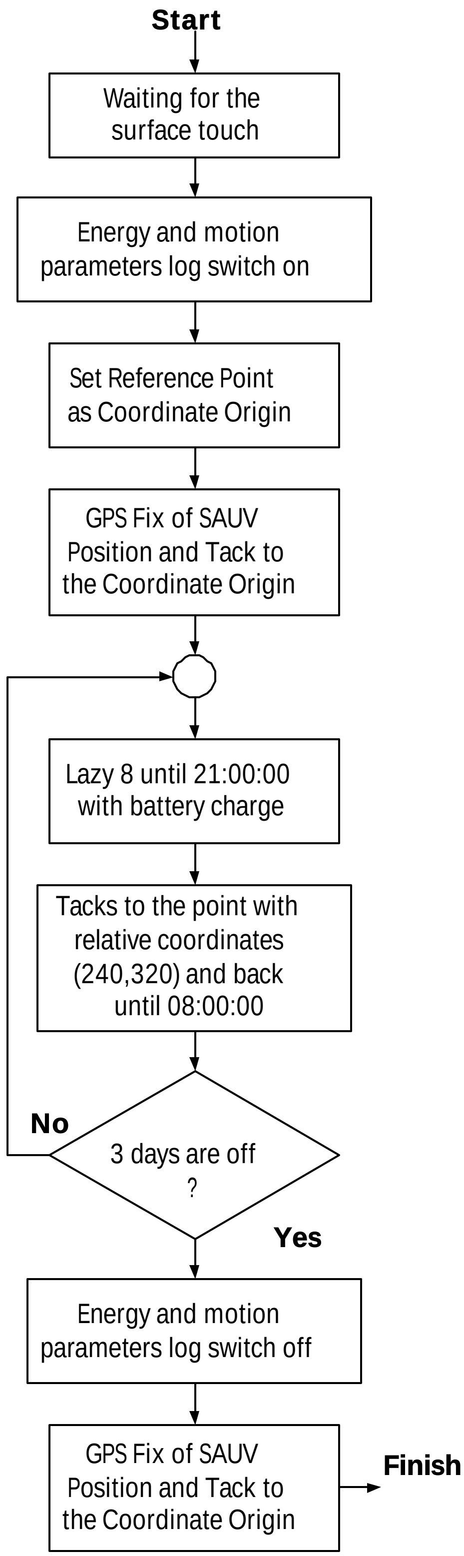

Fig.2a. Task for mission m54.

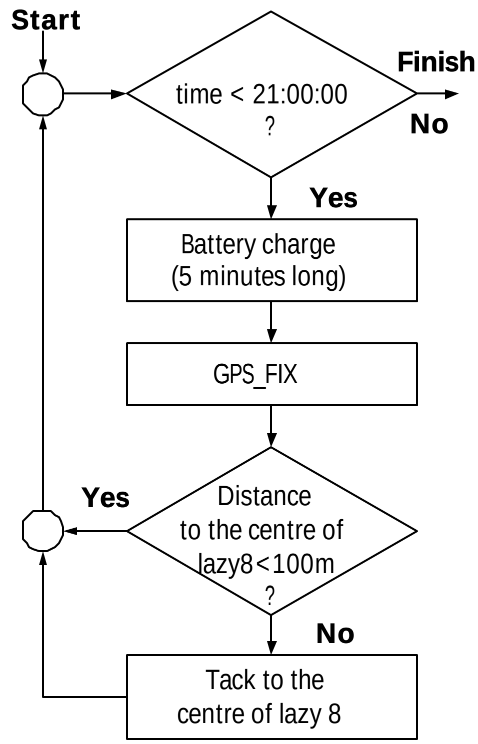

Fig.2b. Lazy 8 with battery charge.

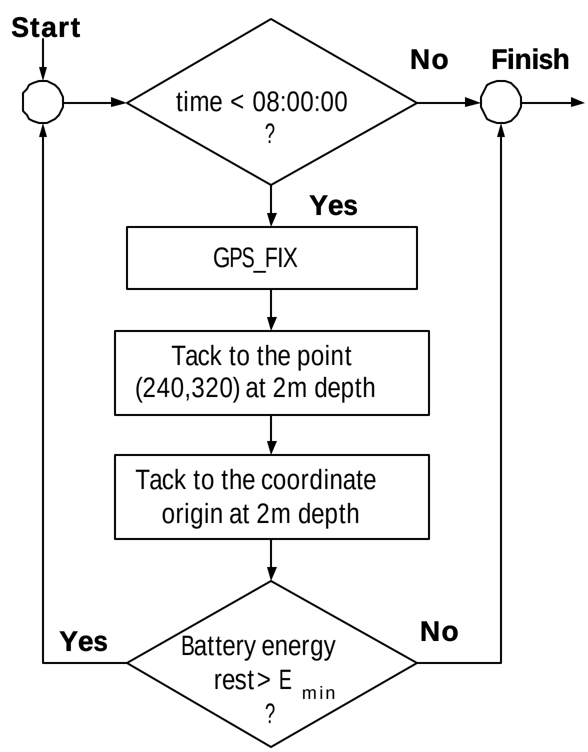

Fig.2c. SAUV operation.

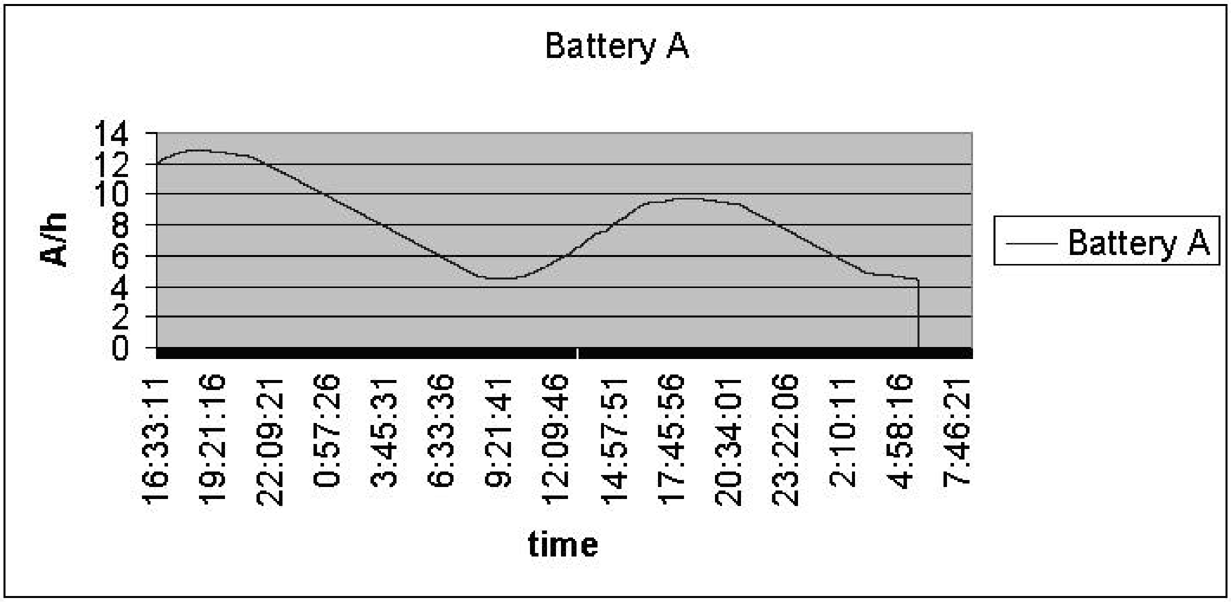

Fig.3a. Energy balance of A battery.

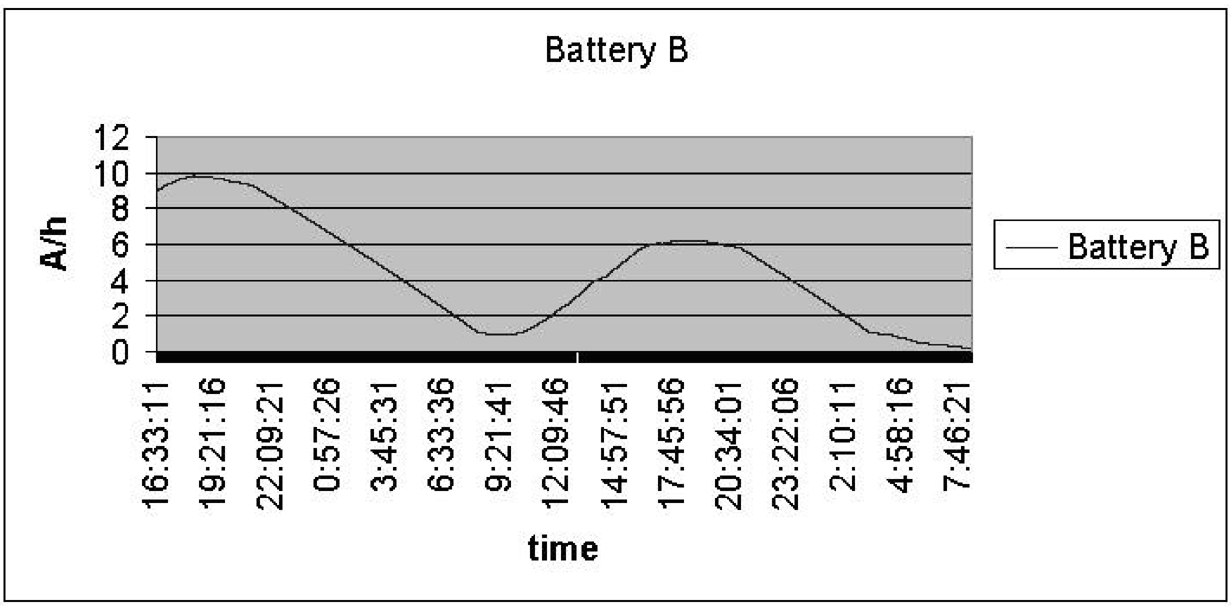

Fig.3b. Energy balance of B battery.

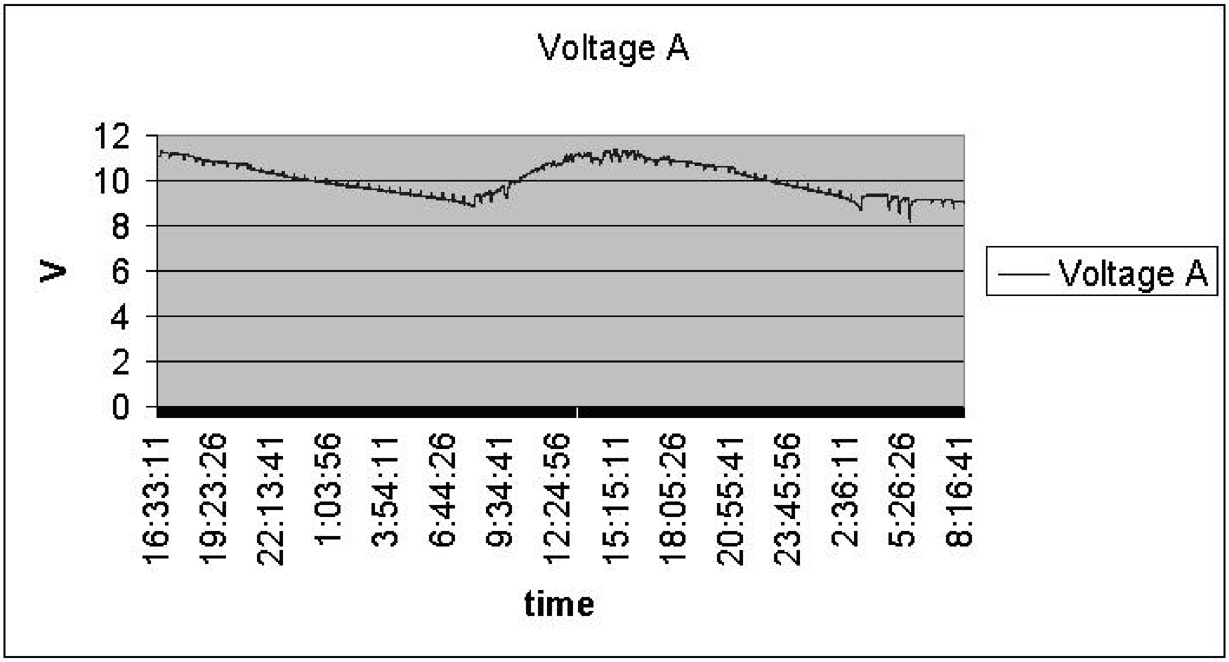

Fig.4a. Voltage from battery A.

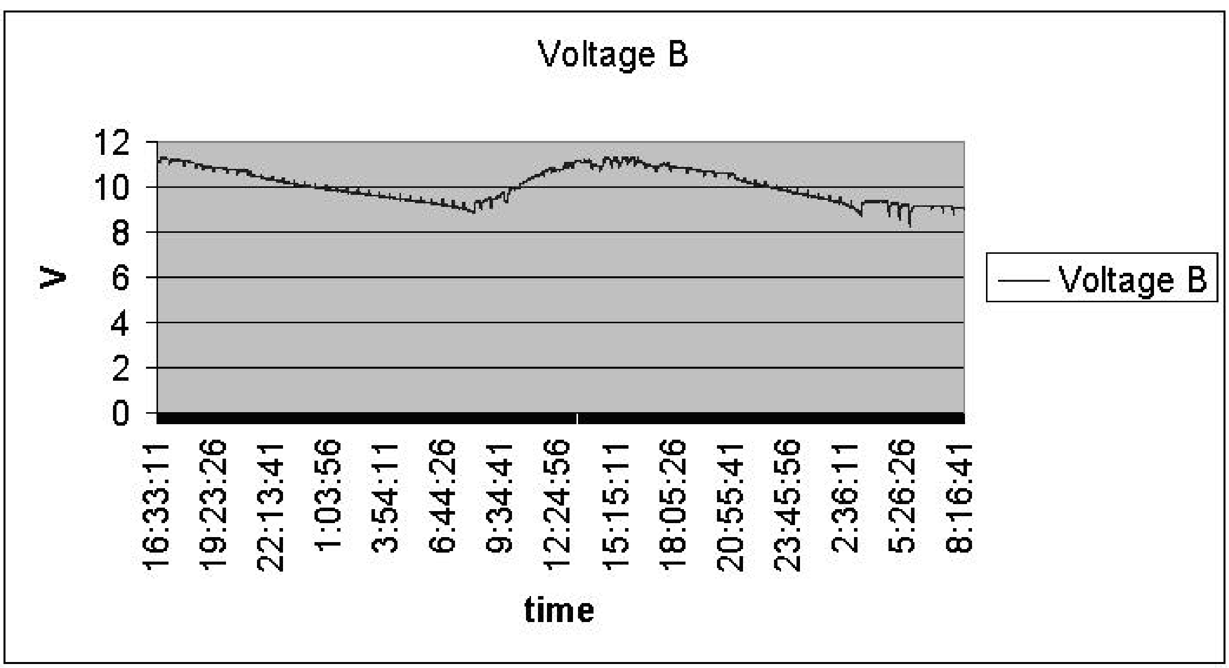

Fig.4b. Voltage from battery B.

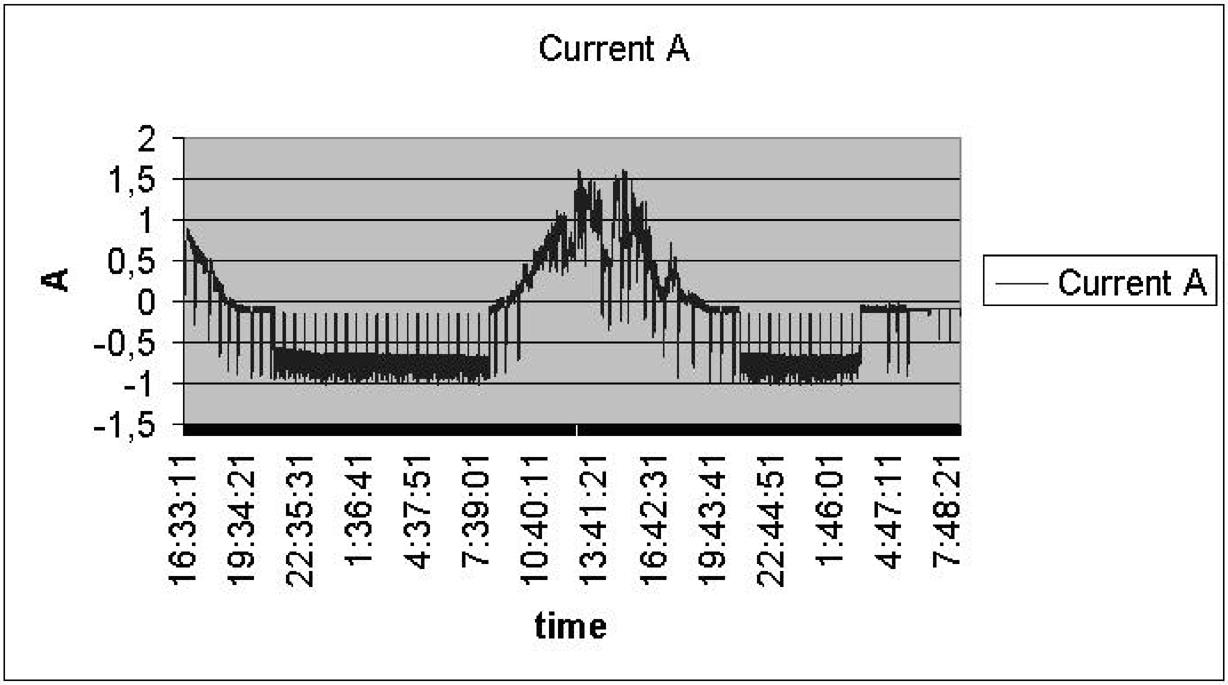

Fig.5 a. Current from battery A.

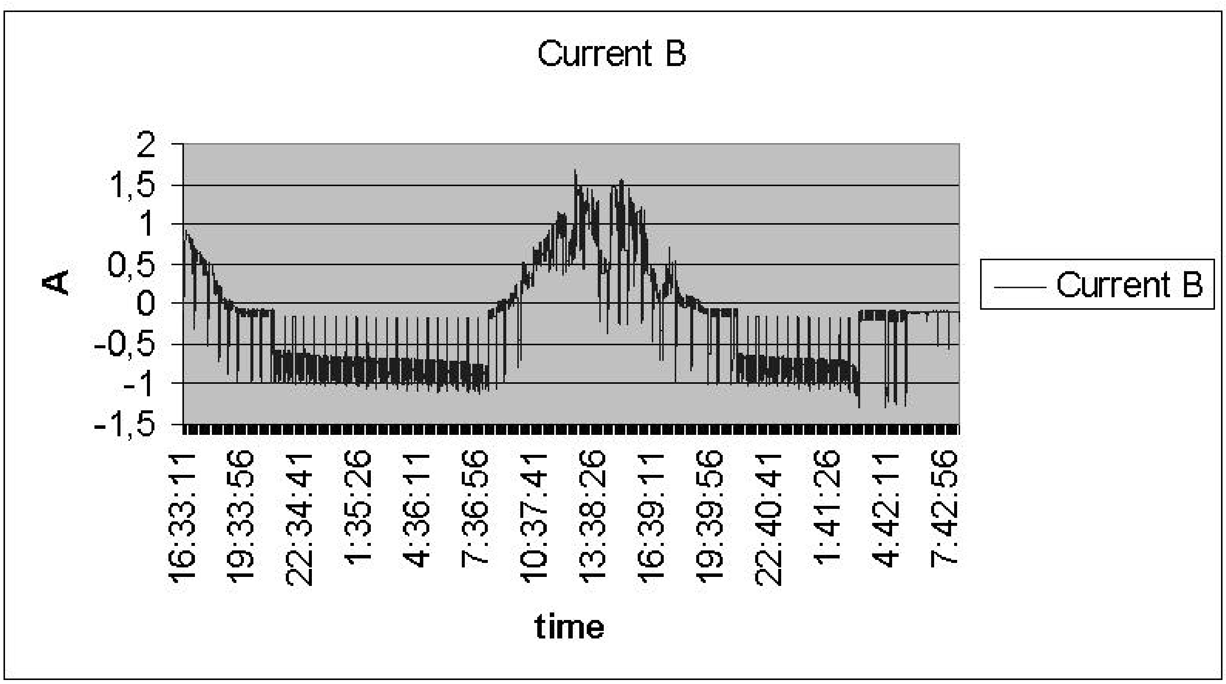

Fig.5b. Current from battery B.

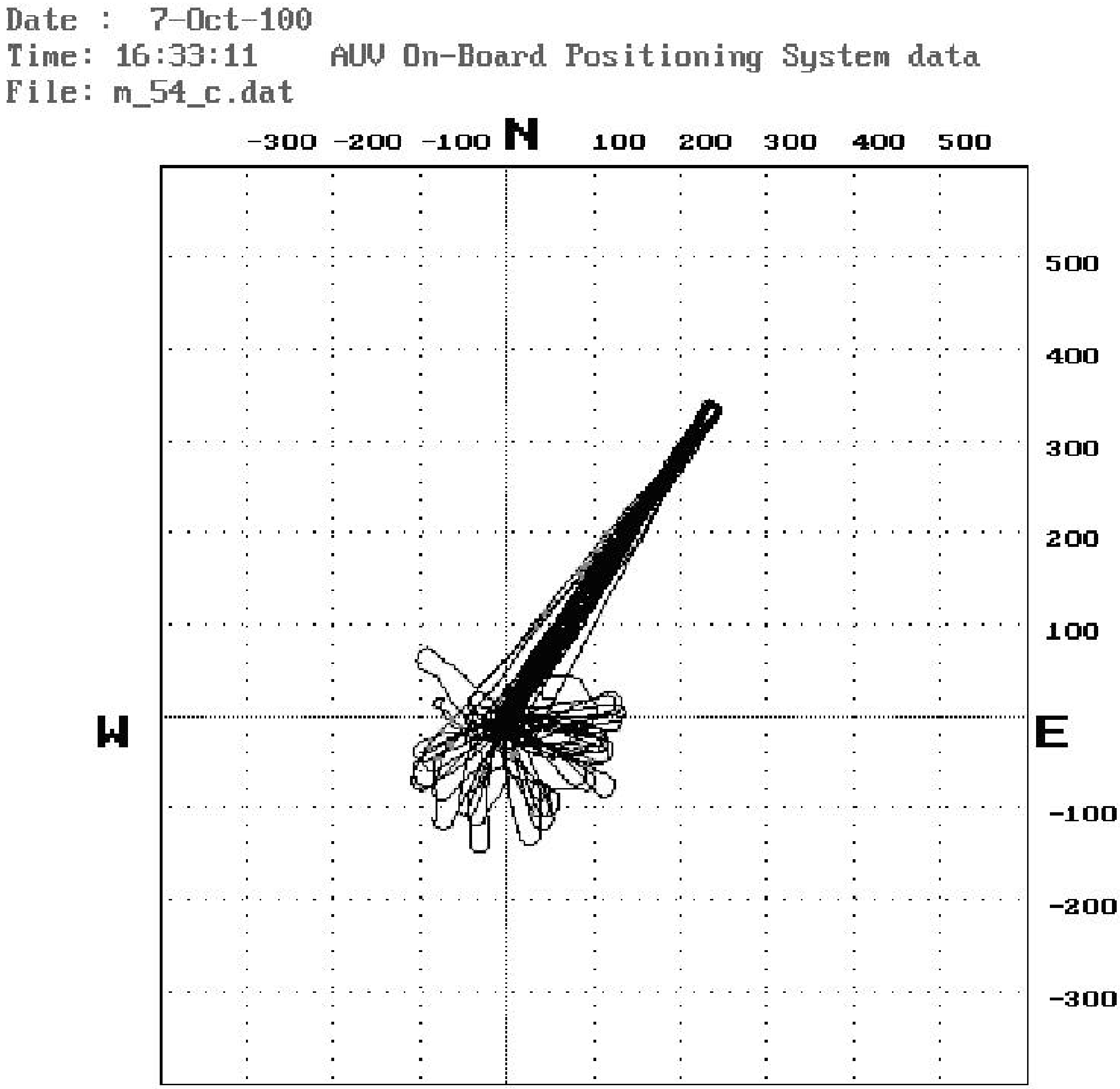

Fig.6. SAUV trajectory from mission m54.

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