EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE

CERN-PS DIVISION

PS/PO/Note 2002-207 (Tech.)

HIGH TENSION CONTROL SYSTEM FOR THE ISOLDE ON-LINE ISOTOPE SEPARATORS
(with DSC – VME/LynxOS based controller)

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Geneva, Switzerland
2 December, 2002

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Introduction

The ISOLDE consolidation project was defined and started in fall 2000 to bring the radiation safety to a level compatible with European legislation and to consolidate the facility so as to make sure that the required number of shifts per year can be delivered. The ISOLDE consolidation project is structured in a number of sub-projects; the sub-project related to the upgrade of the controls has the mandate

1) *Consolidate the front-end part of the ISOLDE control system*
   and
2) *Integrate this latter with the PS controls infrastructure.*

The upgrade of the control system has been identified as one of the activities required for the ISOLDE consolidation. The above mentioned points have an enormous impact on the control system for the High-Tension target supply control system, since the ISOLDE HT control system bears no common elements with the PS control system.

As the recently installed HT control system (fall 2000), an Industrial CompactPCI system running under Windows NT [ref. 1] will not suit any longer, hardware and software will have to be replaced by the PS front-end controls, a VME-LynxOS based Device Stub Controller (DSC).

This note describes the functionality and configuration of the ISOLDE HT control system in the above-mentioned PS control infrastructure, in particular the DSC hardware & control software which forms the heart of the control system.

A short description of a user interface, the HT control application program, is given.
This interface is available for the HT control system, both in Visual Basic and in Java, simplifying direct access to the essential properties.

Furthermore a brief overview of the HT supply, HT source & modulator, is given, in order to obtain a global picture of the overall system.

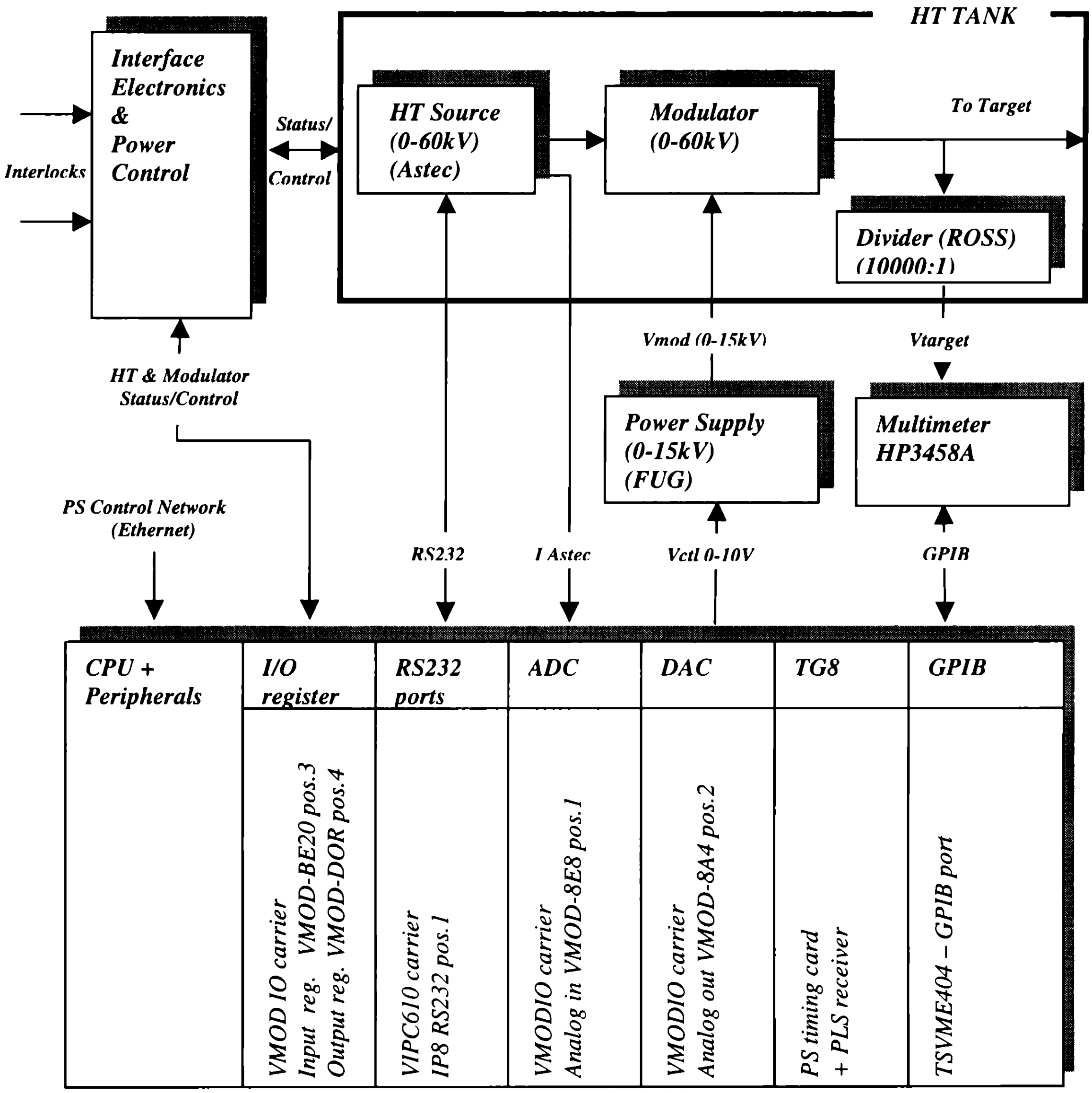
In this note reference is made to directories and servers containing source code and application programs. Although care is taken to maintain their location, these are always liable to change.

I would like to thank Jerome Allard a PS/CO, cooperant during the year 2001, for his excellent contribution to this project in particular the creation of the equipment module and its control synchronization mechanism as well as the construction of an extended GPIB library for the requested HT measurements.

1 The HT control system principle

The principal task of the HT control system is to supply the target potential for ion acceleration and control a modulator for this target voltage. This modulator has the task to fully discharge the target capacitance prior to beam impact and to then restore the voltage close to its nominal value.

The HT control system layout



The HT source (Astec Very High Power - reference 7), a fast acting high stability hard tube power supply, applied to the target is modulated (if requested) by an externally controllable power supply.

This power supply is a commercially available (FUG - reference 8) 0-15kV, 400 J/s capacitor recharging power supply which operates at approximately 11.6 kV to resonate the target voltage through 60kV. The desired output voltage is obtained by applying an external control voltage (0 - 10Vin gives 0-15kVout). The output of the modulator connected to the target is fed back via a 10000:1 high voltage divider (ROSS reference 9) to a high precision multimeter HP3458A. See reference 2 for more details on the modulator principle.

The ISOLDE ion separator facility consists of two separators, the General Purpose Separator (GPS) and the High Resolution Separator (HRS).
The 2 HT supplies, HT1 and HT2, can be connected to either one of the separators by means of a manually-operated high voltage rotary switch (HT-SWITCH), or they can be floated or connected to ground. This results in a very flexible set-up in case of special requirements or breakdown.

Both separators have their own HT supply and associated hardware.
However all control functions are situated in the same control crate. This crate, a VME-bus based system, forms the heart of the control setup together with the Interface Electronics.

The tasks it has to perform are:

Control tasks:
- HT control
- Modulator control

Acquisition and Status tasks:
- Read HT source voltage
- Read HT target voltage
- Read HT output current
- Read HT status
- Read modulator status

1.1 HT control

The HT source is controlled via an opto-isolated RS232 link;

ACTION		**COMMAND**	
Set HT	(0-60kV)	"HV=[value]"	
Set HT on		"HV= ON"	
Set HT off		"HV =OFF"	
Set slope up speed	(kV/sec)	"HVSI = [value]"	
Set slope down speed	(kV/sec)	"HVSO = [value]"	
Set protect mode		"*x1<CR><LF>"	"*x3<CR><LF>"
Set no protect mode		"*x0<CR><LF>"	"*x2<CR><LF>"

HVSI & HVSO refer to the speed at which the HT can ramp 'up' or 'down'.
Commands "HVSI" and "HVSO" return set slope speeds.
"HV" returns HT level in kV
([value] allows two decimal places, unit is kV, resolution approximately 15V)

'No protect' mode makes HT supply less sensitive to high voltage sparking: it disables the software-controlled dropout when HT falls 10% below requested value. Care has to be taken when used since it increases the possibility in damaging the HT supply.

1.2 Modulator control

The modulator has four basic control commands: ON, OFF, STANDBY and RESET.

These commands are sent to the modulator via the Interface Electronics and are negative TTL logic levels. There is another signal called STROBE, which is used to latch commands into the Interface Electronics.

The protocol is assigned so that when a command is activated, the STROBE should be activated at the same time and the command should remain active for a minimum of 1msec after the strobe is negated. The STROBE length should be greater than 5msec. This way of command latching prevents spurious signals at the command inputs to activate undesired control over the modulator.

Modulator control voltage for the FUG power supply 0-10V This control voltage sets desired modulator voltage and is a function of HT source voltage.

1.3 Acquisition and status tasks

HT source voltage is read via a RS232 link.

HT target voltage is read with HP3458A multimeter; voltage is first divided by a high voltage divider 10000:1.

This measurement has a resolution of up to 6 1/2 digits, depending on the settings of the multimeter.
This resolution corresponds to 10^{-5} V accuracy for the scaled target voltage, equivalent to 0.1V for the target voltage. (10V full scale on the HP3458A corresponds to 100kV)
The multimeter is completely software controllable via the GPIB bus.
Furthermore this device can be used for graphing purposes i.e. one can visualize the HT performance.

HT output current is measured through a 1kohm resistor in the current monitoring feedback loop of the HT supply. This gives a direct readout conversion value in mA.

Status of the modulator and HT is returned by the Interface Electronics and contains the following data:

Bit	Meaning	Comment
0	OFF	modulator off
1	ON	modulator on
2	STANDBY	modulator standby
3	TRANSITION	modulator warming up
4	REMOTE/LOCAL	modulator local/remote
5	OK	no interlock
6	MAINS ON	220V present on Interface Electronics
7	HV PULSING	modulator ON & HV ON
8	HV STATIC	modulator STANDBY & HV ON
9	HV ON	
10	HV OFF	

2 VME Hardware

Previously mentioned control & acquisition tasks, result in the following hardware requirements for one separator:

2 - RS232 control ports for HT control
1 - DAC (analog out) port for modulator control voltage
1 - ADC (analog in) port for HT output current measurement
5 channel output register for modulator control
11 channel input register for status information

Both HT supplies share the following hardware:

GPIB bus for HP multimeter control.
8 channel input register for HT switch status

2.1 Hardware selection & configuration

The selected VME plug in cards for the complete HT control system:

1 x IP-Octal 232 (8 independent RS232 channels)

Channel	**Function**
0	HT1 control & acquisition
1	HT2 control & acquisition
2	HT1 Voltage monitoring (future development)
3	HT2 Voltage monitoring (future development)

1 x GPIB TSVME404 Control of HP measurement device

2 x VMOD-8E8 (8 differential multiplexed analog inputs, 8bit-ADC)

Channel	**Function**
0	HT-source current measurement (scale 0-5V, resolution 20nA/bit)

2 x VMOD-8A4 (4 unipolair multiplexed analog outputs, 8bit-DAC)

Channel	**Function**
0	Modulator control voltage (scale 0-10V, resolution 40mV/bit)

There is an output relay for disconnecting the analog output from the connectors.

2 x VMOD-BE20 (20 channels opto isolated input register)

Channel	**Function**
0	OFF
1	ON
2	STANDBY
3	OK
4	REMOTE
5	TRANSITION
6	MAINS ON
7	HV PULSING
8	HV STATIC
9	HV ON
10	HV OFF

2 x VMOD-DOR (16 channels open collector output register)

Channel	Function
0	OFF
1	ON
2	STANDBY
3	RESET
4	STROBE

The maximum voltage that can be supplied to the VMOD-DOR is 70V with maximum current of 300mA.

1 x VMOD-TTL (2 x 8 channels I/O)
Register A is used for HT-SWITCH status decoding

3 The PS control system model

The PS control system is based on equipment names, every equipment is also known as a physical device e.g. HT power supply, has a unique ASCII name and is registered in the control system database.
Each equipment is a member of an equipment type, called class.
A class describes all parameters that can control this type of equipment.
Every parameter is identified by an ASCII name, called property. The implementation of a class and its properties is carried out in an equipment module, residing in the Front End Computer (Device Stub Controller, DSC in the PS jargon).
These DSC's form the link between the application programs running on the consoles and the equipment.

The DSC comprises a real-time UNIX compatible Operating System, LynxOS, which allows several tasks to run concurrently. A DSC is a diskless system, which means that a DSC file server is required to provide remanent storage space for the operating system, system startup files, real-time tasks and their data files.
The DSC provides a fast and deterministic response to external events, which is necessary when operating in Pulse to Pulse Modulation mode (PPM).

PPM - operations whereby a system performs a function upon the arrival of a particular event sent by the PLS and performs the same function upon every subsequent similar event without re-programming.

PLS - program line sequencer; timing system consisting of a bit stream, containing information such as user, cycle and particle type.

The class name for the HT control is ***HTCTL*** and the name of the DSC is ***disoht***.
This DSC contains the control and acquisition of two equipment's:

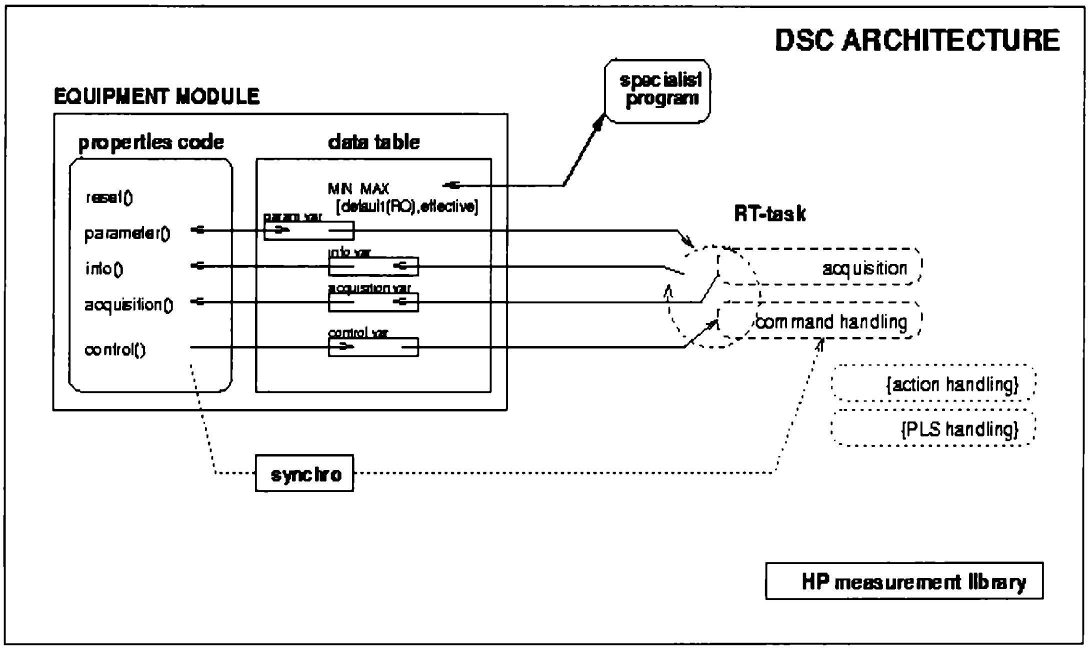
HT1.HTCTL
HT2.HTCTL

These two equipments, one for the General Purpose Separator (GPS) control and one for the High Resolution Separator (HRS) control are instances of the HTCTL class.

HTCTL properties are accessible via (http://oraweb01.cern.ch/psowa/owa/w3gm.gmclass?class=htctl) and can also be found in Appendix B.

3.1 Equipment Access

A function ("procos" - Property Codes) and data set to control the device is available for the user through the so-called Equipment Module (EM). This EM is the device control gateway.



The EM is the only way for the user to communicate indirectly with the hardware.
The real-time task running on the VME controller module performs read and write operations to and from the data table, and can access the physical equipment directly.
As a general rule, it is always good to separate conceptually the EM from the real-time task and let the latter be the only "equipment driver"

As for the EM it is just an interface for applications. It permits to initialize the system, get and set parameters, read information, get acquisitions and also transmit hardware commands to the commands handling background task.
The EM also handles reboot and reset to a default configuration. Furthermore an additional facility through a specialist program exists so as to manipulate some sensitive variables (demand voltage min, demand voltage max, slope max, slope down, slope up and more).

Source code for the EM can be found on the PS servers in /ps/src/dsc/co/em/htctl.

3.2 Real-time task for the HT control

The real-time task for the HT control is a multi-threaded C program, running on the LynxOS platform.

Source code of the real-time task can be found on the PS servers in /ps/home/schipper/isolde/htctl.
The HP & GPIB development can be found in the hp and gpib subdirectories.

Initialization phase:

Sequence of actions taken after the start of ***main()***

- Attach to the PLS telegram received by the TG8, VME timing module – future option
- Initialize hardware
- Launch ***main(), ctl()*** and ***acq()*** threads - (possibly ***pls()*** and ***action()*** for future options)
- Wait for signals

- Main thread ***main()***
main() has the highest priority and checks for 'signals'
The real-time task supports signals SIGHUP, SIGINT, SIGQUIT, SIGTERM. When it receives one of these signals main() wakes up and terminates the program after 'cleaning up'

- Control actions thread ***ctl()***
ctl() thread sleeps until woken by the semaphore received from the equipment module. When the semaphore signal is received it reads the FLAGSET instance variable from the data table which indicates the control action to perform.

FLAGSET's weight:

1	HV demand (CCV)
2	Modulator control
4	HT control
8	HVSI
16	HVSO
32	HP device control <specialist>

When the requested action has been performed it will go back to sleep and wait until the next signal arrives.

- Data Acquisition thread ***acq()***
acq() thread looks after the data acquisition and writes all relevant data to the data table. This data collecting is done sequentially for both the HT supplies every so many seconds.

Data written to the data table is:

- HV value received from HT source
- Output current
- Modulator Status
- HT Status
- HV from HP measurement device (more later)
- HT-SWITCH status

PROTECT/NO PROTECT mode:
Since it is impossible to read which mode the HT source is in, PROTECT mode is the default value and will be set at the start of the real-time task. The HT source always starts in PROTECT mode after power

up, therefore when the status of the modulator is OFF (the only case where the HT source is not powered), the PROTECT bit in the HT status word will be set.

HV trip:
In case of an HV trip, the target voltage will go negative when the modulator is triggered and this has to be prevented. This state can be detected by checking the modulator status (STAQ); this status word will only have the ON bit set. When this is the case the real-time task will put the modulator to standby and will therefore block the timing to the modulator and prevent it from triggering. The real-time task acknowledges this action by setting the bit "HV Trip Indicator" in the STAQ property.

- Optional threads
***pls()* thread**
This thread can be implemented for future requirements. It allows the reading of PLS information, for example user number and particle type.

***action()* thread**
With this thread one can detect external well-defined timing event interrupts delivered by the TG8 VME timing module and perform any desired action. This thread can easily be added for future requirements.

4 The HP 3458A Multimeter

4.1 Control & acquisition

The HP multimeter is controlled via the GPIB protocol and measures the HT target voltage for both GPS and HRS; it distinguishes two tasks depending on the contents of property TYPE:

1. Standard mode
2. Graphing mode, visualization of the HT target voltage (resonance, recovery, ripple and specialist acquisition)

TYPE (working mode)

0	- standard mode	
1	- graph mode (ripple)	=> HT performance
2	- graph mode (recovery)	=> HT recovery after modulation
3	- graph mode (resonance)	=> Modulated HT at target collision
4	- graph mode (specialist)	=> User defined HP settings

All these modes are preset in the HP device, except for the specialist mode (See Appendix C.2).
At DSC boot time the real-time task loads these measurement routines, as well as some configuration routines into the HP device and these will remain resident, even when power off.
This has the advantage that after a power cut off or the device disconnection, it will be active again as soon as it is online without any action from the real-time task.
Furthermore this setup releases the DSC CPU, and minimize GPIB load.

Measurement Modes

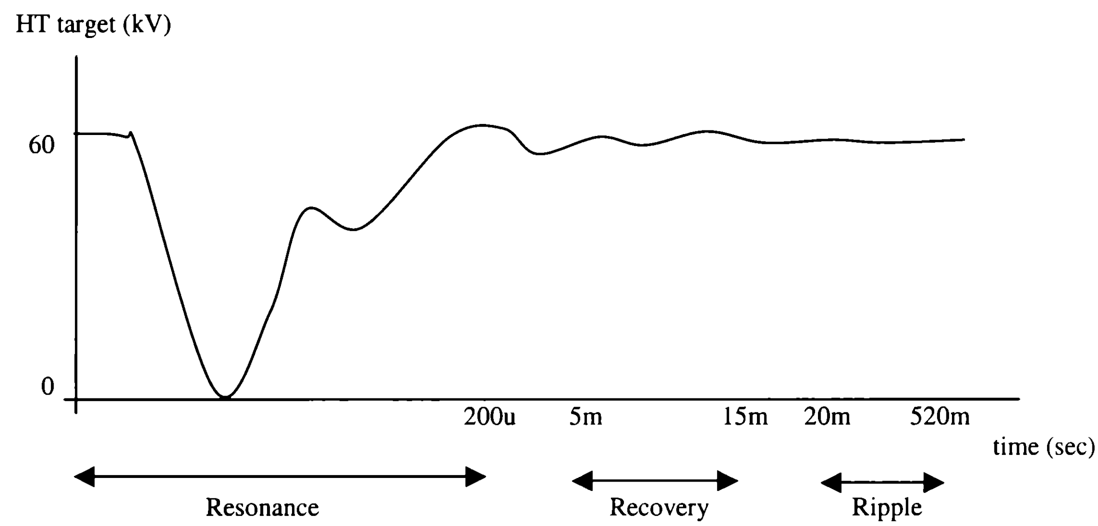
- *Standard mode (Property TYPE=0)*

This is the mode the real-time task puts the HP device in by default. In this mode, as previously mentioned in the acq() thread description, the HT target voltage is measured with a precision of 6 1/2 digits, on a 10V scale, which means a precision of 0.1Volt (0-10V => 0-100kV).
This measurement is repeated every acquisition or until switched to graph mode.

- *Graph mode (Property TYPE=1 to 4)*

The real-time task will perform the requested graphing mode and the next acquisition the HP device will be back in normal mode.
Graphing mode allows the user to visualize HT behaviour with the help of an application program.

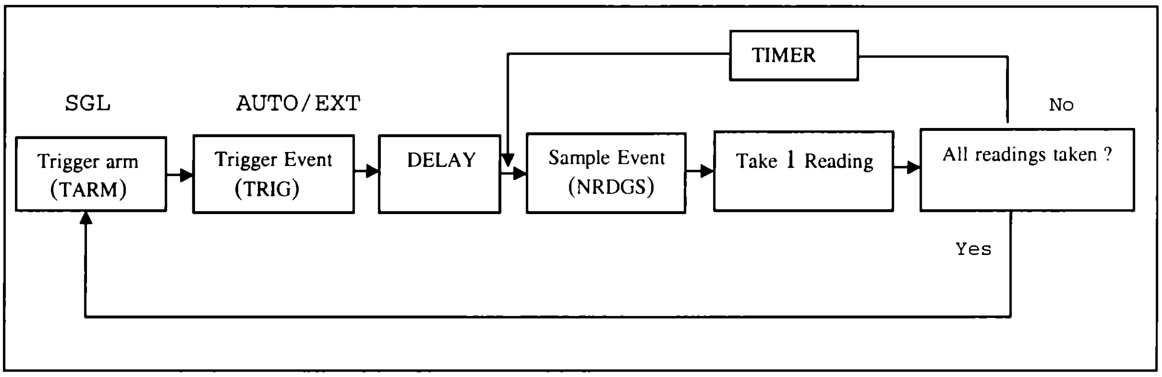
The following graph indicates the preset HP measurements regions:



Modulated Target Voltage (logarithmic view)

The HP is triggered with the same signal that starts the modulator. External triggering is activated when the status of the modulator indicates HV pulsing. If the status has any different value, the HP will be forced triggered.
If the HT system status is HV pulsing but no trigger signal is present, the measurement will be timed out, returning an error message "NO TRIGGER HP"
In this case another measurement will be made with a forced trigger but only for standard mode.

4.2 HP measurement process for predefined measurement layout is :



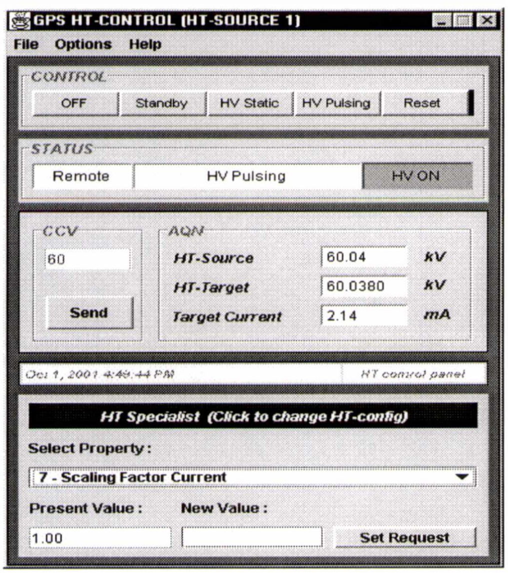
After TARM event starts the process, the HP multimeter is dedicated to the measurement:

- No processing of any other command until job is done
- Input buffer temporarily disabled
- Not responding except for serial polling and device clear (GPIB layer)

5 The HT control application program

5.1 Main menu

To allow easy access to frequently used properties of the HT supplies, a Java application program, is available for the users. Furthermore an updated Visual Basic application program remains available but will be phased out slowly.



Panel Layout of HT control application program.

The five control buttons have the following functions:

OFF	- Modulator OFF, HT source OFF
Standby	- Modulator in standby (timing blocked), HT source OFF
HV Static	- Modulator in standby (timing blocked), HT source ON
HV Pulsing	- Modulator ON, HT source ON
Reset	- Reset Interlocks

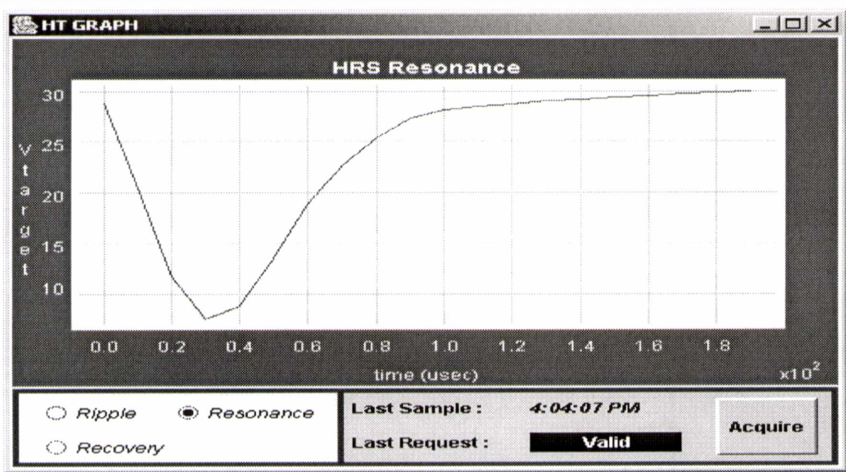
CCV is the requested HT voltage and is activated by pressing **SEND**
HT source is the value returned by the HT source itself
HT target is the high precision HT target voltage measured by the HP-device
With HT specialists rights, i.e. a valid password, selectable with the options menu specialist, the following parameters can be read or written:

1. RSET - set database to initialization values (see Appendix D.1)
2. MAXV - read maximum HT that can be applied
3. MINV - read minimum HT that can be applied
4. DMAX - read maximum slope up/slope down
5. SLOPE - read/write maximum slope up
6. SLOPE1 - read/write maximum slope down
7. SCL1 - read/write current scaling factor
8. SCL2 - read/write HT scaling factor
9. SCL3 - read/write Fug (modulating source) scaling factor
10. Set Protect or NO-Protect mode (if NO-Protect HV ON label changes to HV ON [NP]
11. STAQ - read status modulator (Click on label for more details)
12. STAQ1 - read status HT (Click on label for more details)
13. FREQUENC - read/write data logging time in minutes
14. Re-install HP-device
15. Calibrate HP-device
16. Read HP status (Click on label for more details)
17. Read HP Error (Click on label for more details)
18. Read HP auxiliary error (Click on label for more details)

A HP error list is available under the HELP option, giving a detailed explanation of possible errors. These errors will appear in the location where date/time is displayed (Appendix A.2).

5.2 *Graph Menu*

The Option **'Graph'** makes it possible to visualize the HT behaviour. Below one can see an example with option resonance.



The Show Graph Option

When in HV pulsing mode all graph options are available (specialist only with HT specialist rights). Select the option and activate by pressing **Acquire.**
For a valid request a plot will appear, with a separator name and a time stamp.
If an error occurs the error type will appear in the Last Request box, with further error information from the main HT control panel in the Time/Date box.
HT specialists have the option to enter there own settings by selecting the specialist option: the Acquire button changes into Settings and by clicking the Settings button one can manually set the number of samples, the sample time and the delay after trigger.

6 References

1. High tension control system for the on-line isotope separators – Isolde
   (with CompactPCI front end controller)
   PS/PO Note 2001-068 T.Fowler & J.Schipper.

2. A 60 kV Modulator for the target voltage of an on-line isotope separator
   D.C. Fiander, A.Fowler
   CERN-PS-92-38-RF.

3. HP 3458A Multimeter Operating, Programming and Configuration Manual
   Hewlett Packard Company.
   February 1994

4. Hardware manual MODULbus-series by JANZ COMPUTER AG
   VMOD-8E8 MODULbus analog input (Version 2.1) 24/11/1994
   VMOD-8A4 MODULbus analog output (Version 3.0) 08/03/2000
   VMOD-BE20 MODULbus digital input (Version 1.0) 10/12/1994
   VMOD-BA20 MODULbus digital output (Version 1.0) 17/11/1994

5. VIPC610 User Manual
   Quad IndustryPack Carrier for 6U VMEbus Systems
   GREENSPRING Computers 29/09/1993

6. IP-Octal 232 User Manual
   IndustryPack 8 channel RS232 piggy back
   GREENSPRING Computers 03/06/1994

7. Astec 60kV Precision Power Supply
   Circuit diagrams & Operator's manual
   ASTEC VERY HIGH POWER England

8. Capacitor Charging Power Supplies HCK-Series
   Operating Instructions and Description
   F.u.G. Elektronik GmbH. 11/1994

9. VD120-12.5-BD-K-B High Voltage Divider Calibration Chart
   ROSS Engineering Corporation. 13/09/1990

10. USER MANUAL FOR VMOD-DOR
    PS/CO/Note 94-74 (Tech.) W. Heinze

A Appendix A.

A.1 Property list

Property	Access	Type	Size	Description
AQN	R	D	1	HT source voltage (kV)
AQN1	R	D	1	HT target voltage (kV) - averaged value
AQN2	R	D	1	Output current (mA)
AQN3	R	D	2000	Voltage acquisition of samples array for graphing (kV)
AQNSTAMP	R	I	1	Time stamp acquisition (not used)
CCV	R/W	D	1	Demand voltage
DELAY	R/W	I	1	Post-trigger measurement delay (usec) - graph mode
DMAX	R	D	1	Maximum voltage slopes for HT source (kV/sec)
FREQUENC	R/W	I	1	Sets the voltage data logging frequency in minutes
GENERR	R	I	1	General error description on actions with HP device
GRAPHERR	R	I	1	Error in graphing request
INITL	W	I	0	HTCTL initialization: variables
INTERV	R/W	I	1	Sampling time interval - graph mode (usec)
MAXV	R	D	1	Maximum demand voltage (kV)
MINV	R	D	1	Minimum demand voltage (kV)
NMEAS	R/W	I	1	Number of readings - graph mode
RSET	R	I	0	Reset to default variables
SCL1	R/W	D	1	Scaling factor for current
SCL2	R/W	D	1	Scaling factor for HT voltage
SCL3	R/W	D	1	Scaling factor for FuG
SLOPE	R/W	D	1	Voltage slope up (kV/sec)
SLOPE1	R/W	D	1	Voltage slope down (kV/sec)
SPECVAL1	R/W	I	1	HP control specialist
STAQ	R	I	1	Status Acquisition for Modulator
STAQ1	R	I	1	Status Acquisition for HT
STCC	R/W	I	1	Status Control for Modulator
STCC1	R/W	I	1	Status Control for HT source
STDERR	R	I	1	Error in standard mode
SWITCH	R	I	1	HT-switch status
TEST1	R/W	I	1	Test property
TEST2	R/W	I	1	Test property
TYPE	R/W	I	1	Working mode
ADR1	R	I	1	HP3458A hardware address

A.2 Property significance

STAQ (Status & Acquisition Modulator)

1	OFF
2	ON
4	STANDBY
8	INTERLOCK
16	LOCAL
32	WARMING UP
64	NO 220V
128	HV STATIC
256	HV PULSING
1024	HV Trip Indicator

STAQ1 (Status & Acquisition HT)

1	HT OFF
2	HT ON
4	HT FAULT
8	PROTECT
16	NO PROTECT

STCC (Control Modulator)

1	OFF
2	ON
4	STANDBY
8	RESET

STCC1 (Control HT source)

1	HT OFF
2	HT ON
4	PROTECT
8	NO PROTECT

SWITCH (HT switch status)

Value	Source HT1	Source HT2
1	GPS	HRS
2	GPS	GND
4	HRS	GPS
8	HRS	GND
16	GND	GPS
32	GND	HRS
64	GND	GND
128	FLT	FLT

SPECVAL1 (HP control for specialists)

Value	Action
1	Setup HP device (reinstalls HP)
2	Calibrate HP device (in Voltage range)
4	Check Status HP device
8	Check error HP device
16	Check Auxiliary error HP device

If SPECVAL1 has value 4, 8, 16 GENERR gives detailed error code:

HP Status coding
001 - Subprogram execution completed
002 - Hi or Lo limit exceeded
004 - SRQ command executed
008 - Power on
016 - Ready for instructions
032 - Error <see ERR register>
064 - Service request
128 - Data available

HP Error coding
00001 - Hardware Error
00002 - Calibration Error
00004 - Trigger too fast
00008 - Syntax Error
00016 - Command not allowed
00032 - Undefined parameter received
00064 - Parameter out of range
00128 - Memory Error
00256 - Destructive overload detected
00512 - Out of calibration
01024 - Calibration required
02048 - Settings conflict
04096 - Math error
08192 - Subprogram error
16384 - System error

HP Auxiliary Error Coding
00001 - Slave processor nor responding
00002 - Dtack failure
00004 - Slave processor self test failure
00008 - Isolator test failure
00016 - A/D converter convergence failure
00032 - Calibration value out of range
00064 - HP-IB chip failure
00128 - UART failure
00256 - Timer failure
00512 - Internal overload
01024 - ROM checksum failure, low order byte
02048 - ROM checksum failure, high order byte
04096 - Nonvolatile RAM failure
08192 - Option RAM failure
16384 - Call RAM write or protection failure

This information will stay until a next request is made.

B Appendix B.

B.1 GRAPHERR & STDERR Error List

-1 opening device
-2 close device
-3 setting time out
-4 sending IFC
-5 device clear
-6 serial poll GPIB error
-7 serial poll no answer
-8 send command string too long
-9 send command GPIB error
-10 receive -> buffer not allocated
-11 receive GPIB error
-12 enable remote in gpibLockPanel
-13 set lock panel in gpibLockPanel
-14 hpCheckStatus, spolling
-15 hpCheckStatus, error getting
-16 hpCheckStatus, error getting
-17 hpCheckStatus, auxiliary error getting
-18 hpCheckStatus, auxiliary error getting
-19 hpTestReady, checkStatus
-20 hpTestReady, bad flag
-21 waitHPready, checking status
-22 waitHPready, bad flag
-23 waitHPready, time out
-24 hpConfig, reset order
-25 hpConfig, waiting for reset
-26 hpConfig, deleting non volatile memory
-27 hpConfig, init storage
-28 hpConfig, hpCalib storage
-29 hpConfig, prepAQ storage
-30 hpInit, call
-31 hpCalib, call
-32 gpDevClear, call
-33 hpGetReadings, hpTestReady
-34 hpGetReadings, data not available
-35 hpGetReadings, data reception
-36 hpGetReadings, scale (1)
-37 hpGetReadings - device not RFI
-38 hpGetReadings, scale (2)
-39 hpGetReadings, scale (3)
-40 hpGetReadings, scale (4)
-41 hpGetReadings, no scale
-42 hpGetReadings, to double conversion
-43 hpGetReadings, no real readings
-44 hpBasicMeasurement, devClear(a)
-45 hpBasicMeasurement, bad measurement type
-46 hpBasicMeasurement, call for acquisition launching
-47 hpBasicMeasurement, devClear(b)
-48 hpBasicMeasurement, no trigger received or timeout too short
-49 hpBasicMeasurement, waiting for data
-50 hpBasicMeasurement, devClear(c)

-51 hpBasicMeasurement, getReading
-52 hpBasicMeasurement, devClear(d)
-53 hpBasicMeasurement, tarm hold
-54 hpBasicMeasurement, storeSamples
-55 hpMeasurement, number format
-56 data request too large
-57 hpMeasurement, devClear(a)
-58 hpMeasurement, HP commands
-59 hpMeasurement, devClear(b)
-60 hpMeasurement, no trigger received or timeout too short
-61 hpMeasurement, waiting for data
-62 hpMeasurement, devClear(c)
-63 hpMeasurement, getReading
-64 hpMeasurement, devClear(d)
-65 hpMeasurement, tarm hold
-66 hpMeasurement, storeSamples
-67 hpMeasurement, settings error

C Appendix C.

C.1 HP modes

TYPE (working mode)

0	- standard mode
1	- graph mode (ripple)
2	- graph mode (recovery)
3	- graph mode (resonance)
4	- graph mode (specialist)

The first 4 modes are preset measuring modes
The last mode allows the user to enter the measurement parameters <only for specialists>

C.2 HP preset modes

== Normal acquisition ==

Sampling rate:	5msec => 200 Hz
Integration:	4.95msec
Delay:	50msec
Measurements:	100
Interval:	50 - 550msec
Used format:	DINT-DINT
Accuracy:	6.5 digits

== Ripple acquisition ==

Sampling rate:	500usec => 2 kHz
Integration:	450usec
Delay:	20msec
Measurements:	1000
Interval:	20 - 520msec
Used format:	DINT-DINT
Accuracy:	6.5 digits

== Recovery acquisition ==
Sampling rate: 50usec => 20 kHz
Integration: 40usec
Delay: 5msec
Measurements: 200
Interval: 5 - 15msec
Used format: DINT-DINT
Accuracy: 5.5 digits

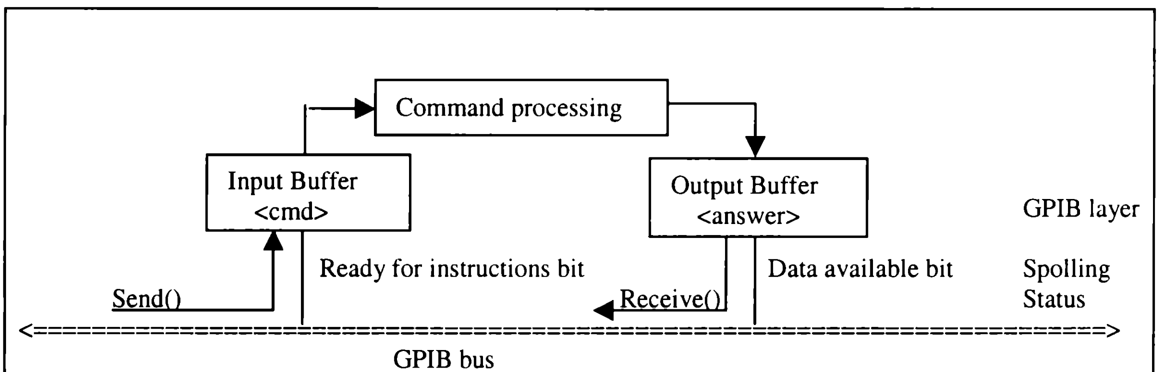
== Resonance acquisition ==
Sampling rate: 10usec =>100 kHz
Integration: 1.5usec
Delay: 0
Measurements: 20
Interval: 0-200usec
Used format: SINT-SINT
Accuracy: 4.5 digits

D Appendix D.

HP input & output buffer configuration

Specifics:

No bus holding (bus is released as soon as <cmd> is stored in the input buffer)
A request cycle: send(cmd) + receive(&answer)
send and receive are not synchronized:
    Send a command if ready for instructions bit is set
    Receive if data available bit is set



Command & Reply Procedure

Used Configuration:
Numerous configurations are possible the one used in the predefined measurements is:

TRIG EXT (AUTO if force triggered)
TARM SGL
NRDGS [n], TIMER

High speed mode:

To allow the HP-device to work in the fastest possible way the following conditions have to be set:

Aperture time < 10 PLC (Power Line Cycles) (200ms)
ARANGE OFF
DISP OFF
MATH OFF
MFORMAT SINT/DINT
OFORMAT SINT/DINT

Memory formats:

Memory format: MFORMAT
SINT/DINT => scale factor required
SREAL/DREAL
ASCII

Output format: OFORMAT
SINT/DINT => scale factor required
SREAL/DREAL
ASCII

SINT => single integer 2 bytes
DINT => double integer 4 bytes
SREAL => single real 4 bytes (IEEE-754 specifications)
DREAL => double real 8 bytes (IEEE-754 specifications)

Note:
Prevent use of ASCII
Use the same format in memory and output:
No conversion required
Obtain readings in 1-step

Device clear use with HP

Command effect:
- Clear GPIB buffers (input and output)
- Abort sub program execution if any
- Abort measurement process if any (triggering disabled)
- Clear status registers
- Clear display

Use:
- Active or preventive device unblocking
- Before and after each measurement
- Without device clear, HP turned out to behave incorrectly frequently

E Appendix E

E.1 Property initialization values after RSET (reset to initial values)

Property			
SCL1	(current scaling factor)	1	
SCL2	(HT scaling factor)	10	
SCL3	(Fug scaling factor)	75	
FREQUENC	(data/error logging interval)	10	(minutes)
DELAY	(delay before measurement starts	0	(usec)
INTERV	(sample time)	0	(usec)
NMEAS	(samples)	0	
TYPE	(working mode)	0	
MINV	(minimum HT)	0	(kV)
MAXV	(maximum HT)	62	(kV)
DMAX	(maximum slope)	10	(kV)
SLOPE1	(slope down)	10	(kV/sec)
SLOPE	(slope up)	10	(kV/sec)
CCV	(demand voltage)	0	(kV)
InstanceVariable			
FLAGSET	(flags for control request)	0	

Eveline Durieu-Thiry

From: Jan Schipper [Jan.Schipper@cern.ch]
Sent: Wednesday, December 04, 2002 10:15 AM
To: Eveline Durieu-Thiry
Subject: Note PS-PO-KM jan

J'ai fini avec la Note,

J'ai quand meme fabrique une liste de distribution car tout les membres du PS me semble un peu trop:

section PS-PO-KM + K. Metzmacher

M. Lindroos	PS/OP
T. Giles	PS/OP
U. Georg	PS/OP
F Locci	PS/CO
G. Mornacchi	PS/CO
J. Lettry	PS/PP
R. Catherall	PS/PP
G.J. Focker	PS/BD
U. Koester	EP/IS