Chapter II

The isegHVOPCServer for iseg Multi-Channel HV systems

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OLE for Process Control (OPC) for the iseg Multi-Channel HV systems

The isegHVOPCServer as a part of OLE process control is the link between the OPC client, the iseg Multi-Channel HV modules and / or the iseg system crates.

1 Introduction

The **iseg** Multi-Channel HV system is made of several devices of hardware and software components. The hardware devices are as follows:

- Multi-Channel HV power supply modules
- System crates carrying the HV modules

Each module and each crate offers a microprocessor based intelligence. The interface which controls and monitors the hardware is the CAN bus. It is following the CAN 2.0B (passive) specification. The data points for the accesses to the module and the crate properties comes together in one executable file and can work on one CAN bus or on different CAN buses in conformity with the configuration files.
The system software interface is made by an OPC server, which follows the rules defined by the OPC Foundation (DA 3.0, 2.0 and 1.0 are supported). Therefore the users of the system must not know the internal protocols in detail.
In order to understand the OPC interface (server namespace), the relevant details of the modules and the crates are described as follows:

2 Modules

Each modules offers up to 32 channels, made of one or two internal cards (PCB). Each internal card represents one CAN node (the most of the modules have 16 channels per card, some modules comes also with another number of channels per card – see instruction "Placed hardware channels" of the EHQ Multi-Channel CAN operators manual). Each channel of the module offers individual properties (see below).
In addition there are properties as groups which summarize a property for all channels and which are controlled by one CAN node.

properties of one channel:

- set voltage write / read
- current trip write / read
- actual current read
- actual voltage read
- status read

properties of a channel group (some examples):

- sum error read
- ramp speed read / write
- set voltage for all channels write
- emergency cut-off write

3 Crates

Properties of a crate (some examples):

- actual voltage of single lines read
- temperature read
- Power ON / OFF read / write
- Status read / write
- StatusACLinePower read

The most important information of the crate is the status of the power supplies.

4 Software

4.1 General information

The ***isegCANHVControl.exe*** control software performs all basic monitor and control tasks for modules and crates. It provides a HMI (human machine interface) for all properties of the modules and crates using the proprietary driver of the CAN interface (PEAK). It can be used in order to configure the modules and crates before the work with the ***isegHVOPCServer***. Such configurations are the flash update, changing the bit rate and identifiers for crates, the offset calibration of the module temperature and the permanent saving of setting values inside of the modules.
An alternative and more general control software is based on the standardized OPC interface. With means of the OPC tools is it possible to establish a sever client system in order to access the iseg Multi-Channel HV system, too. The properties of the Multi-Channel HV hardware can be accessed via the item data points.

5 OPC Server part for Multi-Channel HV devices

The OPC server has been developed using the following tools:

- Softing OPC Toolkit, Ver. 4.10, DA 3.0, AE1.01
- Microsoft's Visual C++, Ver. 6.01
- PEAK System's CAN device driver

The OPC server for Multi-Channel HV system is divided into 'Data Access' part and an 'Alarms and Events' part.

5.1 Configuration

First the OPC server has to be configured. It must get all information about the kind of **iseg** HV hardware connected to the CAN bus. This information is stored in the configuration file ***isegHVOPCServer.ini***. The tool ***isegHVOPCcfg.exe*** is used to create this configuration file. It performs a scan on the CAN bus and collects information from the connected CAN nodes (modules and crates). Also it supports the graphical access to the initialising file ***isegHVOPCServer.ini***.
For further details see the configuration manual ***isegHVOPCSetup.pdf***.

5.2 Data Access Server and Alarm and Events Server

5.2.1 Data Access Server

The OPC DA server is made to work with more than one crate. Therefore each item has to be addressed in a geographical way to build a fully qualified item ID which means:

STATUS.COMPONENT	iseg OPC server components (software releases and status of CAN bus)
CANBUS.NODE.CHANNEL.ITEMNAME	data point for channel depending properties
CANBUS.NODE.ITEMNAME	data point for module depending properties

By the use of a special namespace text file – ***isegHVOPCServer.nsp*** – can build user defined fully qualified item IDs. The description is placed in the file ***isegHVOPCUserNameSpace.pdf.*** The program ***isegHVOPCUserNameSpace.exe*** is able to make a scan over the namespace and save the information prepared to read by the ***isegHVOPCServer*** from the namespace file.

The properties of Multi-Channel HV system in the OPC server are defined as items. In the simplest case, such an item is directly coupled to a read or write via CAN bus. The ‘set voltage’ is one example.
Some OPC items have to be built up from data read results via CAN. The ‘status current limit’ is one example, which is read as an unsigned integer (2 bytes). Each bit of these 2 bytes represents the status of the current limit of one channel. This bit is interpreted as Boolean. All channels result in an array with 16 elements of Boolean, the ‘StatHwILimitBoolArray’.

There is a feature of ranking these many requests because a client can send many of them. First priority is assigned to emergency off ‘Emcy’, second priority to the command set voltage ‘VSet’. All other requests are under normal (lowest) priority.
A background loop process can be used to update the cache of the changeable channel items continuously. This process reads all measurement data and channel status data from the HV modules and fills the cache of the OPC server namespace. To implement a background loop process the “ReadSync” entry in the OPC initialising file “EHQ3216Srv.ini” have to be a different value from zero. The advantages of this mechanism is a very fast update of the really interesting module properties (Vmeas, Imeas and Stat item) because the group update of this items of an OPC client will cause no device reads if the time stamps of the items are as newer as the last update of the group.

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5.2.1.1 Item's properties

The items own a sum of the same and a sum of specific item properties.

Each item has as standard properties: Item Canonical Data Type
Item Value
Item Quality
Item Time Stamp
Item Access Rights
Server Scan Rate
Item Description

Specific item properties: Item EU Type
Item EU
Item High EU (the maximum value that the device will accept and/or return)
Item Low EU (the minimum value that the device will accept and/or return)
Application Description

5.2.1.2 Items of the releases from the server components

Status.release_isegHVOPCServer	isegHVOPCServer.EXE	readable	VT_BSTR
Status.release_isegCAN	isegcanv.DLL	readable	VT_BSTR
Status.CAN	status of CAN bus	readable	VT_BSTR

5.2.1.3 Items of Data Access to the channel properties

Syntax:

t Є [a|p]	module type (active or passive)
x Є [1..16]	number of the CAN bus
yy Є [0..63]	number of the CAN node
zz Є [0..15]	number of the channel

fully qualified identifier	device class	description	access	variant type
can*x*.m*tyy*.ch*zz*.ITrip	0, 1, 2, 3, 5, 8	current trip	write-/ readable	VT_R4
can*x*.m*tyy*.ch*zz*.VMeas	all	actual voltage	readable	VT_R4
can*x*.m*tyy*.ch*zz*.IMeas	all	actual current	readable	VT_R4
can*x*.m*tyy*.ch*zz*.NominalV	3, 5, 6, 7, 8	nominal voltage	readable	VT_UI2
can*x*.m*tyy*.ch*zz*.NominalI	3, 5, 6, 7, 8	nominal current	readable	VT_UI2
can*x*.m*tyy*.ch*zz*.VSet	all	set voltage	write-/ readable	VT_R4
can*x*.m*tyy*.ch*zz*.ISet	5, 6, 7, 8	set current	write-/ readable	VT_R4
can*x*.m*tyy*.ch*zz*.Stat	<20	status channel	write-/ readable	VT_UI2
can*x*.m*tyy*.ch*zz*.Status	>20	channel status	readable	VT_UI2
can*x*.m*tyy*.ch*zz*.Control	>20	channel control	write-/ readable	VT_UI2
can*x*.m*tyy*.ch*zz*.EventStatus	>20	channel event status	write-/ readable	VT_UI2
can*x*.m*tyy*.ch*zz*.EventMask	>20	channel event mask	write-/ readable	VT_UI2

5.2.1.4 Items of Data Access to the module properties

fully qualified identifier	device class	description	access	type
can*x*.m*tyy*.Status	>20	module status	readable	VT_UI2
can*x*.m*tyy*.Control	>20	module control	write-/ readable	VT_UI2
can*x*.m*tyy*.EventStatus	>20	module event status	write-/ readable	VT_UI2
can*x*.m*tyy*.EventMask	>20	module event mask	write-/ readable	VT_UI2
can*x*.m*tyy*.EventChannelStatus	>20	event channel status	write-/ readable	VT_UI2
can*x*.m*tyy*.EventChannelMask	>20	event channel mask	write-/ readable	VT_UI2
can*x*.m*tyy*.GeneralStat	all	general status	readable	VT_UI1
can*x*.m*tyy*.GeneralSumError	all	sum error	readable	VT_BOOL
can*x*.m*tyy*.GeneralStable	all	all channels are stable	readable	VT_BOOL
can*x*.m*tyy*.GeneralSafetyLoop	all	safety loop is closed	write-/ readable	VT_BOOL
can*x*.m*tyy*.GeneralFineAdjust	all	average adjust	write-/ readable	VT_BOOL
can*x*.m*tyy*.GeneralSuppliesTemp	all	supply voltages or module temp	write-/ readable	VT_BOOL
can*x*.m*tyy*.GeneralHwVLimitLow	0	HW voltage limit is to low	write-/ readable	VT_BOOL
can*x*.m*tyy*.GeneralKill	5, 6 ,7, 8	hardware kill enable	write-/ readable	VT_BOOL
can*x*.m*tyy*.StatHardwareVLimit	all	status voltage limit	write-/ readable	VT_UI2
can*x*.m*tyy*.StatHwVLimitBoolArray	all	array status voltage limit	readable	VT_BOOL
can*x*.m*tyy*.StatHardwareILimit	all	status current limit	write-/ readable	VT_UI2
can*x*.m*tyy*.StatHwILimitBoolArray	all	array status current limit	readable	VT_BOOL
can*x*.m*tyy*.StatINHIBIT	7	status current limit	write-/ readable	VT_UI2
can*x*.m*tyy*.StatINHIBITBoolArray	7	array status current limit	readable	VT_BOOL
can*x*.m*tyy*.StatITrip	0, 1, 2, 5, 8	status software current trip	write-/ readable	VT_UI2
can*x*.m*tyy*.StatITripBoolArray	0, 1, 2, 5, 8	array status software current trip	readable	VT_BOOL
can*x*.m*tyy*.StatRegulationErr	0, 1, 2	status regulation error	write-/ readable	VT_UI2
can*x*.m*tyy*.StatRegErrBoolArray	0, 1, 2	array status regulation error	readable	VT_BOOL
can*x*.m*tyy*.On	all	channel on=1, off=0	write-/ readable	VT_UI2
can*x*.m*tyy*.OnBoolArray	all	array on	write-/ readable	VT_BOOL
can*x*.m*tyy*.VSetAllChannels	all	set voltage of all channels	write-/ readable	VT_R4
can*x*.m*tyy*.ITripAllChannels	0, 1, 2, 5, 8	set current trip of all channels	write-/ readable	VT_R4
can*x*.m*tyy*.ISetAllChannels	5, 6, 7, 8	set current of all channels	write-/ readable	VT_R4
can*x*.m*tyy*.RampSpeed	all	ramp speed	write-/ readable	VT_R4
can*x*.m*tyy*.Emcy	all	emergency off	write-/ readable	VT_UI2
can*x*.m*tyy*.EmcyBoolArray	all	array emergency off	write-/ readable	VT_BOOL
can*x*.m*tyy*.KillEnable	0, 1, 2	kill enable	write-/ readable	VT_UI2
can*x*.m*tyy*.KillEnableBoolArray	0, 1, 2	array kill enable	write-/ readable	VT_BOOL
can*x*.m*tyy*.NominalV	all	nominal voltage	readable	VT_UI2
can*x*.m*tyy*.NominalI	all	nominal current	readable	VT_UI2
can*x*.m*tyy*.ADCFilterFrequency	all	ADC filter frequency	readable	VT_UI2
canx.mtyy.DeviceID	all	device identifier	readable	VT_BSTR
canx.mtyy.SoftwareID	all	software release	readable	VT_BSTR
canx.mtyy.BitRate	all	bit rate	readable	VT_UI2
canx.mtyy.Option	>20	options	readable	VT_BSTR
canx.mtyy.OptionSingleSpec	>20	option single specification	write-/ readable	VT_BSTR
canx.mtyy.OptionSpec	>20	specification	readable	VT_UI1
canx.mtyy.HardwareILimit	all	hardware current limit	readable	VT_R4
canx.mtyy.HardwareVLimit	all	hardware voltage limit	readable	VT_R4
canx.mtyy.Supply24V	all	supply 24V	readable	VT_R4
canx.mtyy.Supply15V	all	supply 15V	readable	VT_R4
canx.mtyy.Supply5V	all	supply 5V	readable	VT_R4
canx.mtyy.Supply-15V	0, 6	supply -15V	readable	VT_R4
canx.mtyy.Supply-5V	0, 6	supply -5V	readable	VT_R4
canx.mtyy.BoardTemp	all	board temperature	readable	VT_R4
canx.mtyy.AllocCh	1, 2, 3, 5, 7, 8	allocated hardware channels	readable	VT_UI2[*2]
canx.mtyy.ChnNotOK	1, 2, 3, 7	channels don't work properly	readable	VT_UI2

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canx.mtyy.ErrThreshold	0, 1, 2, 3, 6, 7	threshold of error evaluation	write-/ readable	VT_UI2
canx.mtyy.ConfigRelFErr	0, 1, 2	configuration mask (of relay and regulation error)	write-/ readable	VT_UI1
canx.mtyy.Polarity	5	electronical polarity switch	write-/ readable	VT_UI1
canx.mtyy.Alive	all	module is alive	readable	VT_BOOL

5.2.1.5 Items to signal an alarm from the HV devices via Data Access

fully qualified identifier	device class	description	access	type
canx.mtyy.Alarm	all	alarm status	readable	VT_BOOL
canx.mtyy.AlarmInformation	all	alarm information	readable	VT_UI1

The items “Alarm” and “AlarmInformation” are implemented as event driven update inside of the ***isegHVOPCServer***. These two items are included (on request of Cern) in order to have an access to the fast alarm messages of the modules. The better way is to use the faster “Alarm & Event” part of the ***isegHVOPCServer***. Since version 4.01 the items as there are “Alarm” and “AlarmInformation” can be cleared by reset of the corresponding status bit. If an error occurs the “alarm status” will become to a *true* value. The error of the modules can be reset only by a reset of the reason of the error followed by writing a *‘1’* to the corresponding status bit.
The item “AlarmInformation” describes the kind of the alarm (see Hints to the item alarm information). “Alarm” and “AlarmInformation” are refreshed by the server if a new alarm is attempted but the client will register the new alarm only if the DA-value has been changed.

5.2.1.6 Items to handle the Condition Related Events of the Alarm and Event server

If the check box “Alarm conditions” was selected during the configuration of the ***isegHVOPCServer.cfg*** file the following items are included in the name space.
The bounds of data slots will set to the full range of corresponding HV module when the OPS server is started. In this case the “Condition Related Events” are always inactive. Via an OPC client the slots can be changed and it will be possible to activate a “Condition Related Event” (see also below 5.2.2.3 Condition Related Events).

canx.m*tyy*.ch*zz*.VoltageSlot.VMeasSlot	actual voltage	write-/readable	VT_R4
canx.m*tyy*.ch*zz*.VoltageSlot.VlBoundSlot	lower voltage bound	write-/readable	VT_R4
canx.m*tyy*.ch*zz*.VoltageSlot.VuBoundSlot	upper voltage bound	write-/readable	VT_R4
canx.m*tyy*.ch*zz*.CurrentSlot.IMeasSlot	actual current	write-/readable	VT_R4
canx.m*tyy*.ch*zz*.CurrentSlot.IlBoundSlot	lower current bound	write-/readable	VT_R4
canx.m*tyy*.ch*zz*.CurrentSlot.uBoundSlot	upper current bound	write-/readable	VT_R4

5.2.1.7 Notes to the item *Status channel*

can*x*.m*tyy*.ch*zz*.Stat status channel readable VT_UI2

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
v	c	k	e	r	o	p	x	i	x	x	x	x	x	s	t

can*x*.m*tyy*.ch*zz*.Stat status channel writeable VT_UI2

b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
v	c	k	e	-	o	-	-	i	-	-	-	-	-	s	t

t	current trip	t = 0	channel is ok
		t = 1	V_O shut of 0V because software current trip was exceeded. see to [1]
s	sum error	s = 0	channel is ok
		s = 1	detection of a sum error - consist of an OR between current and voltage limit error in time slots of 1ms which means that it exists a error in the regulation of the channel, see to [1]
x	no information		
i	INHIBIT (device class 7 only)		
		i = 0	channel is ok
		i = 1	detection of an INHIBIT, see to [1]
p	input-error	p = 0	no input-error
		p = 1	wrong message to control the module
o	switch channel to	o = 0	channel OFF
		o = 1	channel ON, see to [1]
r	ramping	r = 0	voltage is stable
		r = 1	voltage ramps
e	emergency cut-off	e = 0	channel works
		e = 1	cut-off V_O shut off to 0V without ramp, see to [1]
k	kill function	k = 0	kill function disable V_O shut off if current limit was exceeded and then V_O is ramping from 0V to V_{SET}
		k = 1	kill function enable, see to [1] V_O shut off permanently if current limit was exceeded
c	current limit error	c = 0	channel is ok
		c = 1	V_O shut off 0V because hardware current limit was exceeded, see to [1]
v	voltage limit error	v = 0	channel is ok
		v = 1	V_O shut of permanently because voltage limit was exceeded, see to [1]

For detection of a current or voltage limit error flag the firmware must evaluate the channel voltage at first.

[1] The status flag is write-able also and when there is a corresponding *Alarm* flag it will be reseted by writing the *Status channel* with set this bits to “1”.

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5.2.1.8 Notes to the item *Channel status*

can*x*.m*tyy*.ch*zz*.Status channel status readable VT_UI2

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
isVLIM	isCLIM	isTRP	isEINH	isVBND	isCBND	res	res	isCV	isCC	isEMCY	isRAMP	isON	IERR	res	res

isVLIM	isVoltageLimitExceeded	voltage limit set by V_{max} is exceeded
isCLIM	isCurrentLimitExceeded	current limit set by I_{max} is exceeded
isTRP	isTripExceeded	Trip is set when Voltage or Current limit or Iset has been exceeded (when KillEnable=1)
isEINH	isExtInhibit	External Inhibit
isVBND	isVoltageBoundsExceeded	Voltage out of bounds
CBND	isCurrentBoundsExceeded	Current out of bounds
isCV	ControlledByVoltage	Voltage control
isCC	ControlledByCurrent	Current control
isEMCY	IsEmergencyOff	Emergency off without ramp
isON	IsOn	On
isRAMP	IsRamping	Ramp is running
IERR	InputError	Input error
res	Reserved	

isVLIM=0 channel is ok
isVLIM=1 the hardware voltage limit is exceeded
isCLIM=0 channel is ok
isCLIM=1 the hardware current limit is exceeded
(to detect a hardware voltage or current limit error flag the firmware has to evaluate the channel voltage and current at first)
isTRP=0 channel is ok
isTRP=1 V_O is shut off to 0V without ramp because the channel has been tripped.
isEINH=0 channel is ok
isEINH=1 External Inhibit was scanned
isVBND=0 channel is ok
isVBND=1 |Vmeas-Vset| > Vbounds
isCBND=0 channel is ok
isCBND=1 |Imeas-Iset| > Ibounds (to detect a voltage or current out of bound flag the firmware has to ramp the channel voltage Vset at first)
isCV=1 channel is in state of voltage control
isCC=1 channel is in state of current control
isEMCY=1 channel is in state of emergency off, VO is shut off to 0V without ramp
isON=0 channel is off
isON=1 channel voltage follows the Vset value
isRAMP=0 no voltage is in change
isRAMP=1 voltage is in change with the stored ramp speed value
IERR=0 no input-error
IERR=1 incorrect message to control the module

5.2.1.9 Notes to the item *Channel control*

can*x*.m*tyy*.ch*zz*.Control channel control write-/ readable VT_UI2

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
res	res	res	res	res	res	res	res	res	res	setEMCY	res	setON	res	res	res

setEMCY	setEMCY	Emergency
setON	SetOn	Set On
res	Reserved	

setEMCY=0 channel works
setEMCY=1 cut-off V_O shut off to 0V without ramp
setOn=0 switch the channel to OFF
setOn=1 switch the channel to ON
(If Vset has been set to a value unequal to zero (0V) before the status bit 'isOn' is changed from (1) one to (0) zero a ramp down of the voltage to zero (0V) will be started.)

5.2.1.10 Notes to the item *Channel event status*

can*x*.m*tyy*.ch*zz*.EventStatus channel event status write-/ readable VT_UI2

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
EVLIM	ECLIM	ETRP	EEINH	EVBNDs	ECBNDs	res	res	ECV	ECC	EEMCY	EEOR	EOn2Off	EIER	res	res

EVLIM	EventVoltageLimit	Event: Hardware- voltage limit has been exceeded
ECLIM	EventCurrentLimit	Event: Hardware- current limit has been exceeded
ETRP	EventTrip	Event: Trip is set when Voltage or Current limit or Iset has been exceeded (when KillEnable=1)
EEINH	EventExtInhibit	Event external Inhibit
EVBNDs	EventVoltageBounds	Event: Voltage out of bounds
ECBNDs	EventCurrentBounds	Event: Current out of bounds
ECV	EventControlledVoltage	Event: Voltage control
ECC	EventControlledCurrent	Event: Current control
EEMCY	EventEmergencyOff	Event: Emergency off
EEOR	EventEndOfRamp	Event: End of ramp
EOn2Off	EventOnToOff	Event: Change from state "On" to "Off"
EIER	EventInputError	Event: Input Error
res	Reserved	

An event bit is permanently set if the status bit is 1 or is changing to 1. Different to the status bit an event bit isn't automatically reset. A reset has to be done by the user by writing an 1 to this event bit.

5.2.1.11 Notes to the item *Channel event mask*

can*x*.m*tyy*.ch*zz*.EventMask channel event mask write-/ readable VT_UI2

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
MEVLIM	MECLIM	MECTRP	MEEINH	MEVBNDs	MECBNDs	res	res	MECV	MECC	res	MEEOR	MEOn2Off	MEIERR	res	res

MEVLIM	MaskEventVoltageLimit	EventMask: Hardware- voltage limit has been exceeded
MECLIM	MaskEventCurrentLimit	EventMask: Hardware- current limit has been exceeded
METRIP	MaskEventTrip	EventMask: Voltage limit or Current limit or Iset has been exceeded (when KillEnable=1)
MEEINH	MaskEventExtInhibit	EventMask: External Inhibit
MEVBNDs	MaskEventVoltageBounds	EventMask: Voltage out of bounds
MECBNDs	MaskEventCurrentBounds	EventMask: Current out of bounds
MECV	MaskEventControlledVoltage	EventMask: Voltage control
MECC	MaskEventControlledCurrent	EventMask: Current control
MEEMCY	MaskEventEmergencyOff	EventMask: Emergency off
MEEOR	MaskEventEndOfRamp	EventMask: End of ramp
MEOn2Off	MaskEventOnToOff	EventMask: Change from state on to off
MEIER	MaskEventInputError	EventMask: Input Error
res	Reserved	

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5.2.1.12 Notes to the item *Module status*

can*x*.m*tyy*.Status module status readable VT_UI2

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
res	isTMPgd	isSPLYgd	isMODgd	isEVNTact	isSFLPgd	isnoRAMP	isnoSERR	res	res	res	res	res	res	res	res

isTMPgd	IsTemperatureGood	Module temperature good
isSPLYgd	IsSupplyGood	Power supply good
isMODgd	IsModuleGood	Module in state good
isEVNTact	IsEventActive	Any event is active and mask is set
isSFLPgd	IsSafetyLoopGood	Safety loop closed
isnoRAMP	IsNoRamp	All channels stable, no ramp active .
isnoSERR	IsNoSumError	Module without failure
res	Reserved	

isTMPgd=0 if module temperature is higher than 55°C then all channel are switched off permanently
isTMPgd=1 module temperature is within working range
isSPLYgd=0 supply voltages are out of range (range of 24V +/-10% and of 5V +/-5%)
isSPLYgd=1 supply voltages are within range
isMODgd=0 module is not good, that means (isnoSERR AND (ETMPngd OR ESPLYngd OR ESFLPngd))==0
isMODgd=1 module is good, that means (isnoSERR AND NOT(ETMPngd OR ESPLYngd OR ESFLPngd))==1
(see module event status also)
isEVNTact=0 no Event is active
isEVNTact=1 any Event is active
isSFLPgd=0 safety loop is broken -V_O bas been shut off,
isSFLPgd=1 safety loop is closed
isnoRAMP=0 V_O is ramping in at least one channel
isnoRAMP=1 no channel is ramping
isnoSERR=0 voltage limit, current limit, trip, voltage bound or current bound has been exceeded in at least one of the channels or external INHIBIT ⇒ error, reset by reset of the corresponding flag of the 'Channel Status'
isnoSERR=1 evaluation of the 'Channel Status' over all channels to a sum error flag
⇒ VLIM&CLIM&CTRP&EINH&VBND&CBND=0 ⇒ no errors

5.2.1.13 Notes to the item *Module control*

can*x*.m*tyy*.Control module control write-/ readable VT_UI2

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
res	KILena	res	setADJ	res	res	res	res	res	CLEAR	res	res	res	res	res	res

KILena	KillEnable	Kill function
setADJ	Adjust	Switch ON of fine adjustment
CLEAR	ClearKill	Clear Error signals in all channels
res	Reserved	

KILena=0 kill function disable
KILena=1 kill function enable
setADJ=0 fine adjustment OFF
setADJ=1 fine adjustment ON
bigENDN=0 little endian
bigENDN=1 big endian (MOTOROLA format)

5.2.1.14 Notes to the item *Module event status*

can*x*.m*tyy*.EventStatus module event status write-/ readable VT_UI2

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
res	ETMPngd	ESPLYngd	res	res	ESFLPngd	res	res	res	res	res	res	res	res	res	res

ETMPngd	EventTemperatureNotGood	Event: Temperature is above 55°C
ESPLYngd	EventSupplyNotGood	Event: at least one of the supplies is not good
ESFLPngd	EventSafetyLoopNotGood	Event: Safety loop is open
res	Reserved	

5.2.1.15 Notes to the item *Module event mask*

can*x*.m*tyy*.EventMask module event mask write-/ readable VT_UI2

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
res	METMPngd	MESPLYngd	res	res	MESFLPngd	res	res	res	res	res	res	res	res	res	res

METMPngd	MaskEventTemperatureNotGood	MEventMask: Temperature is above 55°C
MESPLYngd	MaskEventSupplyNotGood	MEventMask: at least one of the supplies is not good
MESFLPngd	MaskEventSafetyLoopNotGood	MEventMask: Safety loop (SL) is open
res	Reserved	

5.2.1.16 Notes to the item *Event channel status*

can*x*.m*tyy*.EventChannelStatus event channel status write-/ readable VT_UI2

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
CH15	CH14	Ch13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0

The n-th bit of the register is set, if an event is active in the n-th channel and the associated bit in the EventMask register of the n-th channel is set too.

CHn = EventStatus[n] & EventMask[n]

Reset of a bit is done by writing a 1 to this bit.

5.2.1.17 Notes to the item *Event channel mask*

can*x*.m*tyy*.EventChannelMask event channel mask write-/ readable VT_UI2

Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
CH15	CH14	Ch13	CH12	CH11	CH10	CH9	CH8	CH7	CH6	CH5	CH4	CH3	CH2	CH1	CH0

This register decides whether a pending event leads to the sum event flag of the module or not. If the n-th bit of the mask is set and the n-th channel has an active event in the EventChannelStatus the bit isEventActive in the ModuleStatus register is set

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5.2.1.18 Notes to the item *General status*

can*x*.m*tyy*.GeneralStat general status readable VT_UI1

b7	b6	b5	b4	b3	b2	b1	b0
save	killena/ hwVLimNoExceed	vsply	avad	stbl	sloop	nramp	sum

sum	sum error flag	sum = 0	voltage limit, current limit or trip were exceeded in the module
		sum = 1	status channel flags v & c & t = 0 for all channels
nramp	no ramp flag	nramp = 0	V_O is ramping at least one channel
		nramp = 1	no channel is ramping
sloop	safety loop flag	sloop = 0	safety loop is broken -V_O has been shut off, clear this bit by reading the general status information
		sloop = 1	safety loop is closed
stbl	stable	stbl = 0	all channels are stable with programmable ADC filter frequency f_N (ADC conversion time =1 / f_N, see 'ADC filter frequency setting', default f_N = 50 Hz)
		stbl = 1	at least one channel is ramping V_O or not yet stable after ramping (with ADC filter frequency f_N = 100 Hz)
avad	average adjust	avad=0	fine adjustment OFF for device classes 0, 6 and 7 average of voltage and current measurement OFF for device classes 1, 2 and 7
		avad=1	fine adjustment ON for device classes 0, 6 and 7 average of voltage and current measurement ON for device classes 1, 2 and 7
vsply	supply voltages	vsply=0	supply voltages or module temperature are out of range
		vsply=1	supply voltages and module temperature are in range
killena	kill enable	killena=0	kill function disable, only at modules of device class 6 and 7
		killena=1	kill function enable only at modules of device class 6 and 7
hwVLimNoExceed		=0	hardware voltage limit to "Low", only at modules of device class 0
		=1	hardware voltage limit in a proper range, only at modules of device class 0
save	save set values	save=0	no write access to EEPROM
		save=1	store all set values to EEPROM (time to save ca. 10s)

sn. serial numbers

5.2.1.19 Notes to the items VsetAllChannels, ITripAllChannels and ISetAllChannels

All items are readable since isegHVOPCServer release 4.10. The items VsetAllChannels, ITripAllChannels and IsetAllChannels has been implemented for a fast possibility to set all channel items of the same kind such as VSet on a value. The read access of the OPC items VsetAllChannels, ITripAllChannels and IsetAllChannels deliver only the value from cache of the OPC server which has been written as last. The really value of the channel items can be differ for instance in case of a mix module or a hardware limit and others but the channel items VSet, ITrip and ISet contain always the proper values.

5.2.1.20 Notes to the item *Configuration of the relay and regulation error*

acanx.m*t*yy.ConfigRelFErr configuration of relay and regulation error write-/readable VT_UI1

b7	b6	b5	b4	b3	b2	b1	b0
x	x	CACO	CRErr	CSLoop	CTrip	CVErr	CCLimit

CCLimit discharge if the hardware current limit was exceeded at least one channel

CVErr discharge if the hardware voltage limit was exceeded at least one channel

CTrip discharge if the software current trip was exceeded at least one channel

CSLoop discharge if the safety loop was active

CRErr discharge if the regulation was out of order at least one channel of (reaction >= 1ms)

CACO discharge if all channels set to “OFF”(Group access module “Channel ON/OFF” or “Emergency cut-off”)

X not used

The relay contacts will discharge capacities connected to the output with help of an integrated load resistor (see Appendix B Operators Manual - Multi-channel High Voltage Power Supply EHQ). This item configures the conditions of how this does work.

Under the setting of one of these conditions and the corresponding error occurs following will happen:

- shut off the HV without ramp in all channels and the set voltage in all channels to 0V by software.
- close contact of discharge relay.

5.2.1.21 Notes to the item *Alarm information*

canx.mtyy.AlarmInformation alarm status readable VT_UI1

b7	b6	b5	b4	b3	b2	b1	b0
$HwV_{Limit\_to\_low}$ / INHIBIT	M_{Temp}	V_{Supl}	S_{Loop}	V_{Limit}	C_{Limit}	R_{Error}	C_{Trip}

C_{Trip}	current trip	$C_{Trip} = 0 \Rightarrow$ no channel has tripped $C_{Trip} = 1 \Rightarrow$ software current trip at least one of the channels
R_{Err}	regulation error	$R_{Error} = 0 \Rightarrow$ no channel has a regulation error (see channel status) $R_{Error} = 1 \Rightarrow$ at least one of the channels has detected a regulation error
C_{Limit}	current limit	$C_{Limit} = 0 \Rightarrow$ no channel has exceeded the hardware current limit $C_{Limit} = 1 \Rightarrow$ at least one of the channels has exceeded the current limit
V_{Limit}	voltage limit	$V_{Limit} = 0 \Rightarrow$ no channel has exceeded the voltage limit $V_{Limit} = 1 \Rightarrow$ at least one of the channels has exceeded the voltage limit
S_{Loop}	safety loop	$S_{Loop} = 0 \Rightarrow$ safety loop is closed $S_{Loop} = 1 \Rightarrow$ safety loop is broken
V_{supl}	voltage supplies	$V_{supl} = 0 \Rightarrow$ supply voltages are in range $V_{supl} = 1 \Rightarrow$ supply voltages are out of range
M_{Temp}	module temperature	$M_{Temp} = 0 \Rightarrow$ module temperature <= 60°C, no action $M_{Temp} = 1 \Rightarrow$ module temperature > 60°C, HV has been switched off
$HwV_{Limit\_to\_low}$ (device class 0 only)		$HwV_{Limit\_to\_low} = 0 \Rightarrow$ hardware voltage limit in range $HwV_{Limit\_to\_low} = 1 \Rightarrow$ hardware voltage limit to low - it is not possible to switch on any channel
INHIBIT (device class 7 only)		INHIBIT = 0 ⇒ no channel has detected an INHIBIT INHIBIT = 1 ⇒ at least one of the channels has detected an INHIBIT

5.2.1.22 Notes to the item *Option*

canx.mtyy.Option option readable VT_BSTR

Option	Description	Specification
“EDCP”	Enhanced Device Control Protocol	no
“HVBM”	HV boards per (CAN nodes) module	no
“CLIM”	hardware current limit	no
“VLIM”	hardware voltage limit	no
”INHB”	external INHIBIT signals	no
“RELY”	discharge relay	no
“FRMP”	fast ramp	yes (1 - 25% of Nominal V, 2 - 50% of Nominal V, 3 - 75% of Nominal V)
“NIPL”	not implemented	

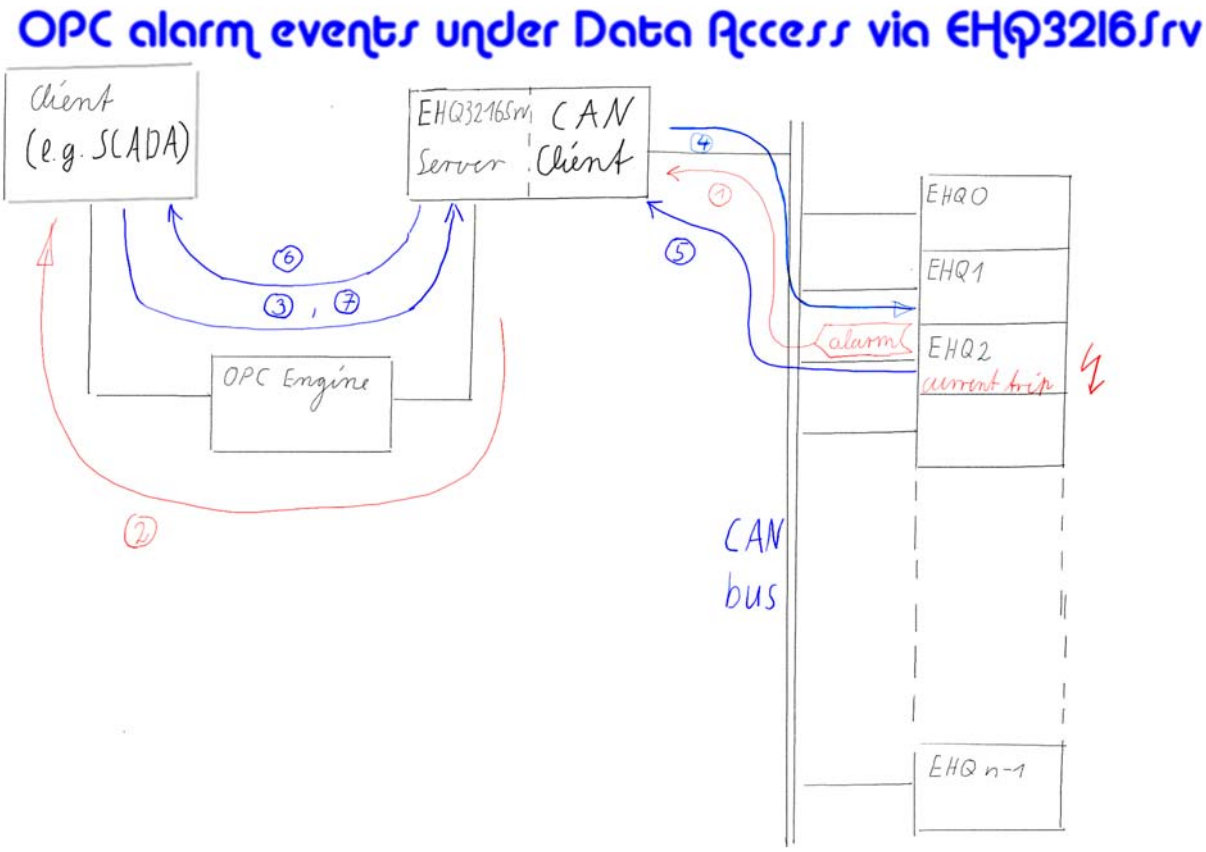
5.2.1.23 Notes to *OptionSingleSpec*

In order to request the specification of one option item *OptionSpec* the corresponding option string have to be written to the item *OptionSingleSpec.*

5.2.1.24 Items for public groups defined by the OPC server:

GroupDeviceID	list of all device identifiers	readable	VT_BSTR
GroupSoftwareID	list of all software identifiers	readable	VT_BSTR
GroupStatHardwareILimit	list of all status current limits	readable	VT_UI2
GroupStatHwILimitBoolArray	list of all arrays status current limits	readable	VT_BOOL
GroupStatHardwareVLimit	list of all status voltage limits	readable	VT_UI2
GroupStatHwVLimitBoolArray	list of all arrays status voltage limits	readable	VT_BOOL
GroupStatITrip	list of all status current trips	readable	VT_UI2
GroupStatITripBoolArray	list of all arrays status current trips	readable	VT_BOOL
GroupStatRegulationErr	list of all status regulation error	s readable	VT_UI2
GroupStatRegulationErrBoolArray	list of all arrays status regulation errors	readable	VT_BOOL
GroupGeneralSumError	list of all sum errors	readable	VT_BOOL
GroupGeneralStable	list of all stable status	readable	VT_BOOL
GroupGeneralSafetyLoop	list of all safety loop status	readable	VT_BOOL
GroupGeneralFineAdjust	list of all fine adjustment flags	readable	VT_BOOL
GroupGeneralHwVLimitLow	list of all HW voltage limit tow low flags	readable	VT_BOOL
GroupBitRate	list of bit rates that are stored in modules	readable	VT_UI2
GroupErrThreshold	list error thresholds	readable	VT_UI2
GroupConfigRelFErr	list of bit mask for relay configurations	readable	VT_UI2
GroupAlarm	list of all alarm status information	readable	VT_BOOL
GroupAlive	list of all alive information	readable	VT_BOOL

If an error occurs it will be signalled by the item *alarm status* in connection with the check of the sum error flag from the item GeneralStat (GeneralStatSumError). These items will catch the errors by read and they will cancel the errors by write with the corresponding channel flag is set to “1”.



(1) A current trip happens and will generate one CAN alarm message with higher priority as the normal messages of the data transfer.

(2) The ***isegHVOPCServer*** sets the item Alarm to TRUE and gives a note of the kind of the alarm by the item “AlarmInformation” (both were build as a reported item in the name space).

(3, 4, 5, 6) The Client has to read which channel has tripped and is able to cancel the error flag by a write of the item “StatITrip” with the corresponding channel flag is set to “1”.

(7) Not necessary up to version 4.0.

5.2.2 Alarms and Events server

The OPC server offers the “Alarms & Events” feature built into the same executable in order to let the OPC client act quickly on a single event or an alarm.

The following alarms and events have been defined:

5.2.2.1 Simple events

canx.ErrorSafetyLoop	error status of safety loop	readable
canx.ErrorSupply	error status of supply voltages	readable
canx.ErrorSumError	error status of general sum status	readable

5.2.2.2 Tracking events

Computer.KeyboardPressed	access to local keyboard on server	readable
Computer.MouseActivity	access to local mouse on server	readable

5.2.2.3 Condition Related Events

The check box “Alarm conditions” have to be selected during the configuration of the ***isegHVOPCServer.cfg*** file. If measured values are exceeding the limits of a defined slot then condition related events are generated. This applies to current and voltage.

canx.mtyy.chzz.VoltageSlot	actual voltage is not between the upper and lower bound (defined in “Data access”)
canx.mtyy.chzz.CurrentSlot	actual current is not between the upper and lower bound (defined in “Data Access”)

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6 OPC server part for iseg system crate *ECHx38*

The OPC server has been developed using the following tools:

- Softing OPC Toolkit, Ver. 4.0 DA3.0
- Microsoft Visual C++, Ver. 6.01
- PEAK System CAN device driver

The executable is included in ***isegHVOPCServer.exe*** also as OPC "Data Access" server and "Alarm and Event" server.

6.1 Configuration

The OPC server has to be configured at the beginning. It must get all information about the kind of **iseg** HV hardware connected to the CAN bus. This information is stored into the configuration file. The tool ***isegHVOPCcfg.exe*** is used to create this configuration file. It performs a scan on the CAN bus and collects information from the connected CAN nodes (modules and crates). Also it supports the graphical access to the initialising file ***isegHVOPCServer.ini***.
For further details see the configuration manual ***isegHVOPCSetup.pdf***.

6.2 Data Access Server and Alarm and Event Server

6.2.1 Data Access Server

The OPC (DA) server is made to work with more than one crate. Therefore each property of the **iseg** system crate has to be addressed in a geographical way to build a fully qualified item ID which means:

CANBUS.CRATE.ITEMNAME

The properties in the OPC server are defined as items. In the simplest case, such an item is directly coupled to a read or write via CAN bus. The "On" is an example. The OPC "Data Access" method is working via request queues.

6.2.1.1 Items of the releases from the server components

6.2.1.2 Items of Data Access

Syntax: *x* Є [1..16] number of the CAN bus
yy Є [0..63] number of the CAN node

can*x*.crate*yy*.Supply24V	crate power 24V	readable	VT_R4
can*x*.crate*yy*.Supply5V	crate power 5V	readable	VT_R4
can*x*.crate*yy*.Battery	battery voltage for the UPS ca. 24V	readable	VT_R4
can*x*.crate*yy*.TempBackPlane	temperature on the back plane	readable	VT_R4
can*x*.crate*yy*.TempPowerSupply	temperature on the DC/DC converter	readable	VT_R4
can*x*.crate*yy*.FanStageBackPlane	stage on the back plane fan unit	readable	VT_UI1
can*x*.crate*yy*.FanStagePowerSupply	stage on the crate power supply fan unit	readable	VT_UI1
canx.crate*yy*.Status	crate power status	write-/readable	VT_UI1
canx.crate*yy*.StatusACLinePower	status of the AC line power	write-/readable	VT_BOOL
can*x*.crate*yy*.On	status of the power	write-/readable	VT_BOOL
can*x*.crate*yy*.DeviceID	device identifier	readable	VT_BSTR
can*x*.crate*yy*.SoftwareID	software release	readable	VT_BSTR
can*x*.crate*yy*.BitRate	bit rate	readable	VT_UI2
can*x*.crate*yy*.Alive	crate is alive	readable	VT_BOOL
canx.crate*yy*.AlarmFlag	alarm status	readable	VT_BOOL
canx.crate*yy*.AlarmInformation	alarm information	readable	VT_BSTR

When the AlarmFlag goes true the item value of AlarmInformation will get one of the following strings:
“EMCY supply 24V”
“EMCY supply 5V”
“EMCY battery 24V”
“Temperature PS”
“Temperature BP”
“AC line power”

If there are more than one alarm sources the item value will display the latest received alarm. With help of the status items it will display all received alarms. It have to reset an alarm by write a one to the corresponding status bit of the Status item or a true to the StatusACLinePower item.

canx.crate*yy*.AlarmValue	alarm value	readable	VT_R4

alarm information – “EMCY supply 24V”	*measurement supply 24V*
alarm information – “EMCY supply 5V”	*measurement supply 5V*
alarm information – “EMCY battery 24V”	*measurement 24V battery voltage*
alarm information – “Temperature PS”	*measurement Temperature PS*
alarm information – “Temperature BP”	*measurement Temperature BP*
alarm information – “AC line power”	*nothing - 0*

The items “AlarmFlag”, “AlarmInformation” and “AlarmValue” are implemented as event driven update inside of the ***isegHVOPCServer***. The “AlarmFlag” will become a true if an error occurs. The “AlarmValue” is the corresponding measurement to the “AlarmInformation” item. The “AlarmInformation” describes the kind of the alarm (see Hints to the item AlarmInformation). The alarm will be generated with help of EMCY ID (see manual ***ECH-CANwithUPS_eng.pdf***). The crate will repeat the alarm trigger until the error will go away. These items are included (on request of Cern) in order to have an access to the fast alarm messages of the crates. The

better way is to use the faster “Alarm & Event” part of the ***isegHVOPCServer***. Since version 4.01 the items as there are “AlarmFlag”, “AlarmInformation” and “AlarmValue” can be cleared by reset of the corresponding status bit. The error of the crate can be reset only by a reset of the reason of the error followed by writing a *‘1’* to the corresponding status bit.
The “Alarm Flag”, “AlarmInformation” and “AlarmValue” will refreshed by the server if a new alarm is attempted but the client will register the new alarm only if the DA-value has been changed.

6.2.1.3 Crate power status

Capture status if voltages were out of range.

b7	b6	b5	b4	b3	b2	b1	b0
temperature to high		+24V to high	+24V to low	+5V to high	+5V to low	24V battery to high	24V battery to low

6.2.2 Alarm and Events Server

The OPC server offers the ‘Alarms & Events’ feature built into the same executable in order to let the OPC client act quickly on a single event or an alarm.

The following alarms and events have been defined:

Simple events:

canx.ErrorSupply24V	error of supply 24V	readable
canx.ErrorSupply5V	error of supply 5V	readable
canx.ErrorBattery24V	error of battery 24V (possible only if the crate power is off)	readable
canx.ErrorTemperaturePS	error of temperature senor on power supply 24V-DC-PS	readable
canx.ErrorTemperatureBP	error of temperature sensor on pack plane	readable
canx.ErrorACline_power	error of AC line power	readable

Tracking events:

Computer.KeyboardPressed	access to local keyboard on server	readable
Computer.MouseActivity	access to local mouse on server	readable