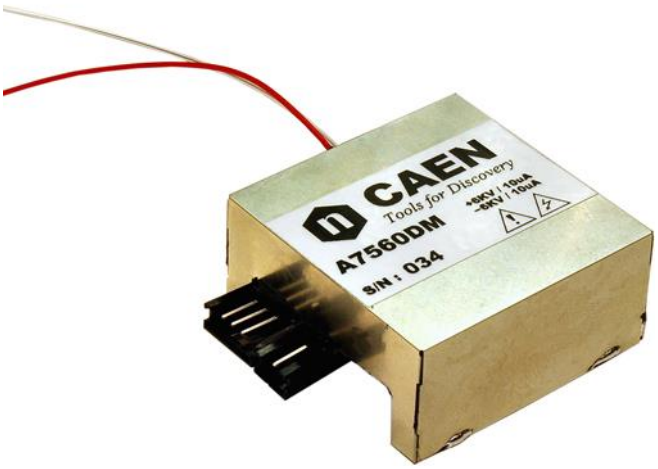
Rev. 3 - 18 June 2018

A7560D

A7560D PCB Power Supply ±6kV 10µA HV PWS Module with Digital Control



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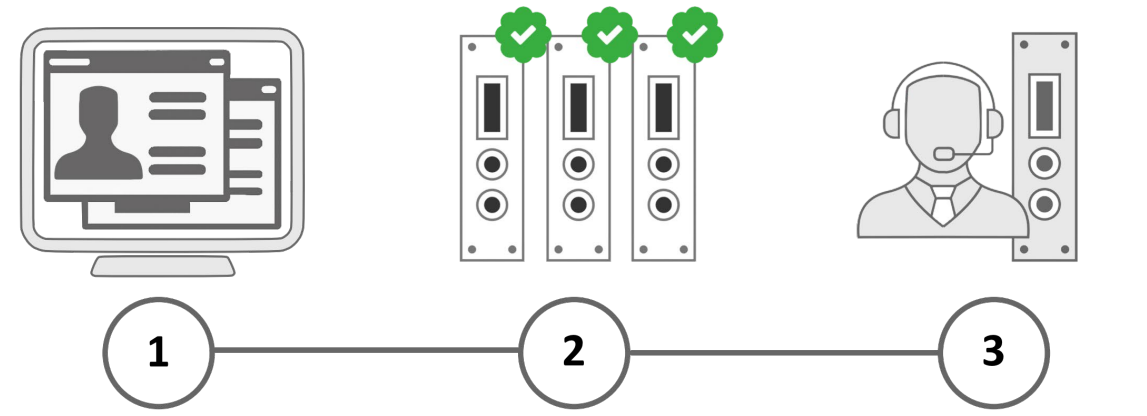
MyCAEN+ dashboard is designed to offer you a direct access to all our after sales services. Registration is totally free, to create an account go to https://www.caen.it/become-mycaenplus-user and fill the registration form with your data.



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Purpose of this Manual

This document is the A7560D PCB Power Supply ±6kV 10µA HV PWS Module with Digital Control user manual; it contains information about the installation, the configuration and the use of the board.

Change Document Record

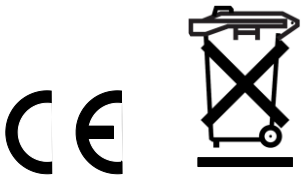
Date	Revision	Changes
22 July 2016	0	Preliminary
22 May 2017	1	New communication protocol
28 August 2017	2	Updated Technical Specifications, A7560 Operation
18 June 2018	3	Updated communication protocol

Symbols, abbreviated terms and notation

N.A.

Reference Documents

N.A.



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1. Overview

The A7560 is a compact low noise double channel High Voltage DC/DC converter in a PCB mount form factor.

It provides a double output High Voltage with opposite polarity according to the user setting. The module features a digital control managed by an embedded low power micro-controller. By running a dedicated resident firmware, it can handle calibration, ramp up/down rates, power-on sequence, inner SPI serial bus and self-compensation of nonlinearities for enhanced accuracy.

The A7560 HV channel is handled by a micro controller that every 5ms updates set voltage and current limit, via a 16bit DAC and sampling voltage and current values via a 24bit sigma delta ADC.

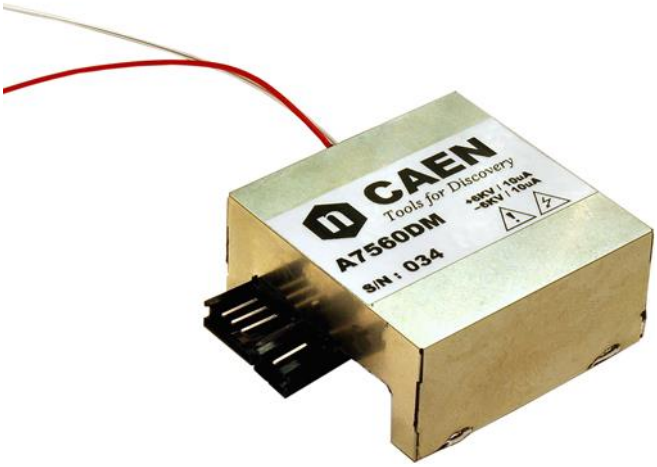
Current changes smaller than 6.5nA are digitally filtered with 500ms time constant.

The unit can be externally controlled and configured by means of an USART serial link. It provides all the relevant information as Voltage and Current monitors, Status and Overcurrent for the safety of detectors as RPCs and others. These features make A7560 suitable for integration in user designed systems or embedded applications. The A7560 is able to work in magnetic field up to 1 kGauss.

Safety Features include:

Overcurrent detection: if the channel attempts to draw a current larger than Iset, the output voltage is automatically adjusted to keep the current below Iset limit. Under this condition, the channel behaves as a current generator:

- Status On/Off Bit: 0 ÷ 5 V (low = OFF)
- Protected against short circuits, sparks and humidity



2. Safety and installation requirements

General safety information

This section contains the fundamental safety rules for the installation and operation of the board. Read thoroughly this section before starting any procedure of installation or operation of the product.

Injury Precautions

Review the following precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use the product only as specified. Only qualified personnel should perform service procedures.

Avoid Electric Overload.

To avoid electric shock or fire hazard, do not power a load outside of its specified range.

Avoid Electric Shock.

To avoid injury or loss of life, do not connect or disconnect cables while they are connected to a voltage source.

Do Not Operate Without Covers.

To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

Do Not Operate in Wet/Damp Conditions.

To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in an Explosive Atmosphere.

To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Do Not Operate with Suspected Failures.

If you suspect this product to be damaged, have it inspected by qualified service personnel.

Safety Terms and Symbols on the Product

These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

The following symbols may appear on the product:

DANGER

High Voltage

WARNING

Refer to Manual

3. Technical Specifications

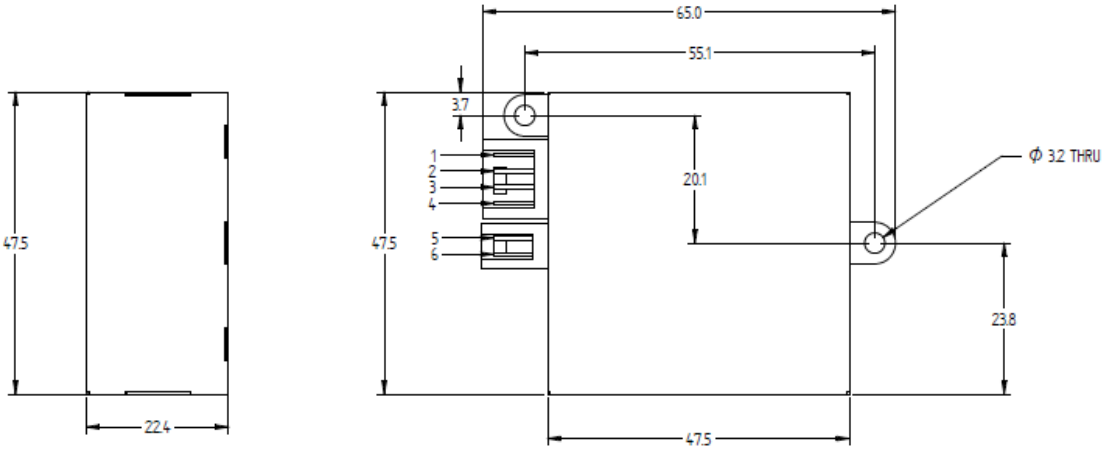
Packaging	Material: DC01; dimension: W=49 mm; L=49 mm ; H=23 mm				
Operating temperature	-10° C ÷ +40° C				
Storage temperature	-55° C ÷ +85° C				
Voltage Supply (Vin)	from +5 V - 20% to +12 V + 10%				
Output Voltage (Vout)	0 ÷ ±6kV				
Output polarity	Double channel, opposite polarity				
Voltage Set/Mon resolution	set: 100mV; mon.: 100mV				
Maximum Output Current (Iout)	10 µA on single rail				
Current Set/Mon resolution	set: 200 pA; mon.: 100 pA				
Ramp Up/Down	1÷500 V/s				
Vmon vs. Vout Accuracy	Typical: ±0.2% ±0.5V Max: ±0.3% ±0.5V				
Imon vs. Iout Accuracy	Typical: ±0.5% ±20nA Max: ±1% ±100nA				
Voltage Ripple **10Hz ÷ 1000Hz**	typical: 10mV; max.: 30mV				
>1000Hz	typical: 10mV; max.: 15mV				
Output power (max)	120mW				
Power requirement	< 2.5 W @ full power				
Serial Line	A7560DM; USART (TX, RX) RS232 Receiver	Min	Typ	Max	Unit
	Input voltage range	-30		+30	V
	Input threshold low	0.6	1.2		V
	Input threshold high		1.6	2.4	V
	Input hysteresis		0.4		V
	Input resistance	3	5	7	KOhm
	RS232 Receiver	Min	Typ	Max	Unit
	Output voltage swing RS232	±5.0	±5.2		V
	Output voltage swing RS562	±3.7			V
	Transmitter output resistance	300			Ohm
	Output short circuit current RS232		±15		mA
	A7560DTM; TTL[1]	Min	Typ	Max	Unit
	Input voltage range		0÷5		V
	Input threshold low		1.75		V
	Input threshold high		3.25		V
	Output threshold low		0.4		V
	Output threshold high		4.6		V
	Iout MAX		±50		mA
Electromagnetic compatibility	Weak emission of electromagnetic impulse and RF; one-piece metal shielding with several ground connections				
Uniformity of a lot	< 1 %				
Protection	Over current short circuit, sparks and humidity				

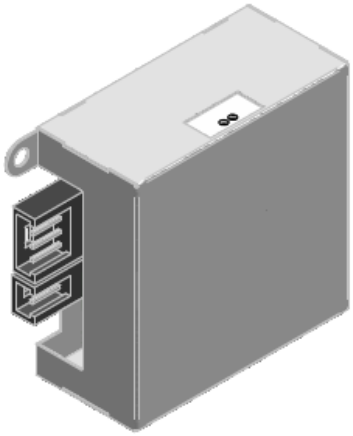
[1] Not compatible with Bit Bidirectional Level-Shifting and Voltage Translator with Auto Direction-Sensing

4. Packaging

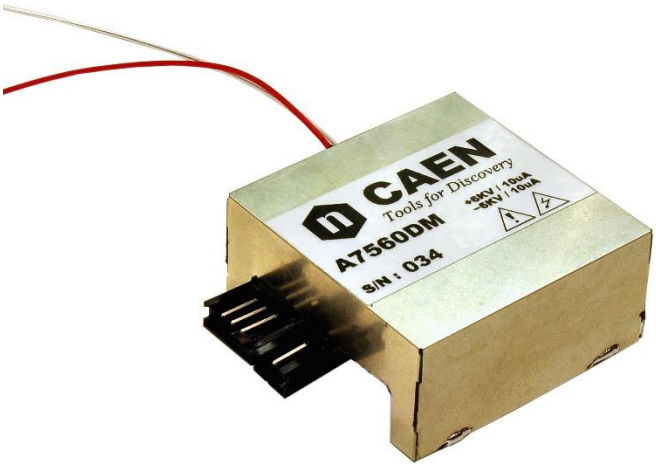
External Connnections

The following diagram describes the Pin assignment of the AMP 280359-0 (pin 1-4) and AMP 280358 (pin 5-6) I/O connectors (pin type: AMP.182206):





Pin #	Description	Direction
P1	Enable	In
P2	Transmitter data	Out
P3	Receiver data	In
P4	Analog ground	Out
P5	Vin	In
P6	Analog ground	Out
Wires		
RED	HV OUT+	
GRAY	HV OUT-	



5. Operating modes

The A7560 is provided with a software tool that allows to access all functional parameters.

Parameter	Function	Unit
VSet	High Voltage programmed value	Volt
ISet	Current Limit programmed value	µA
Ramp-Up	Maximum High Voltage increase rate	V/s
Ramp-Down	Maximum High Voltage decrease rate	V/s
Status	ON/OFF; Ramp UP/DOWN; OVV; UNV; OVC; TRIP; OFF;	
VMon	High Voltage Monitored value	Volt
IMon	Current Monitored value positive rail	µA
IMonN	Current Monitored value negative rail	µA
TRIP	The TRIP parameter value, i.e. the maximum time an Over Current condition is allowed to last.	s
Pw	Power ON/OFF; highlighted green when ON	
PwDown	Power Down mode after channel TRIP	KILL or RAMP

The unit features, for safety reasons, an input current limiter and an enable pin that allows to disconnect the High voltage from the Bus, thus reducing stand-by power consumption.
When the module trips upon Overcurrent, it is necessary to reset the alarm flag, using “R-Clear” function, before next turning on.

WARNING! HV output cables produce extremely hazardous high voltages at a potentially lethal current level; never connect or disconnect the HV OUT cable with the Vin ON; always switch Vin OFF and wait at least 30s before connecting or disconnecting HV cables.

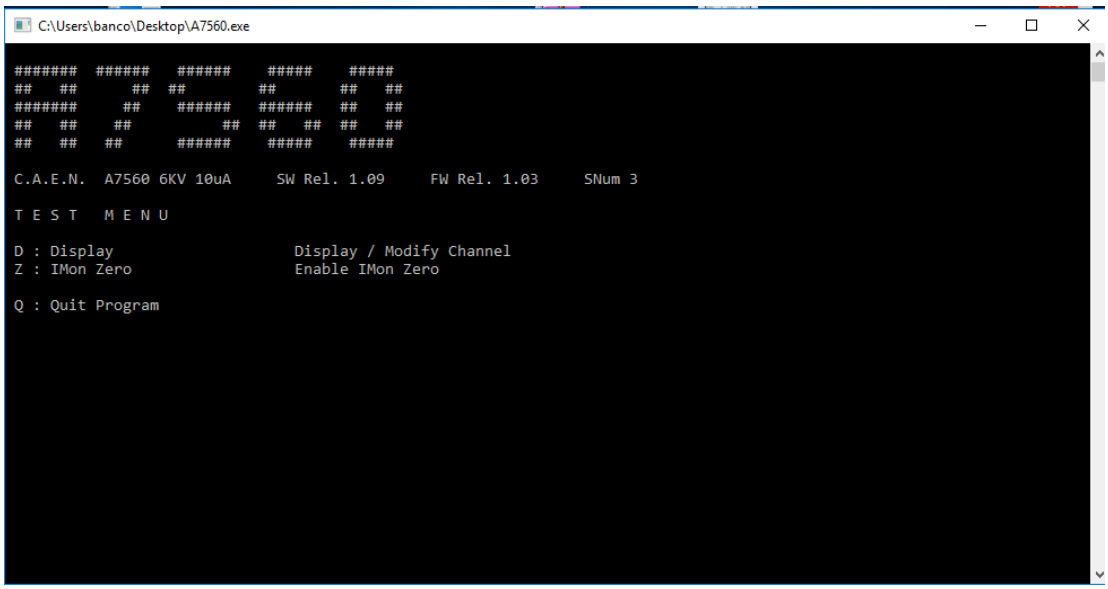
Hardware Set Up

To operate the A7560 the following equipment is required:

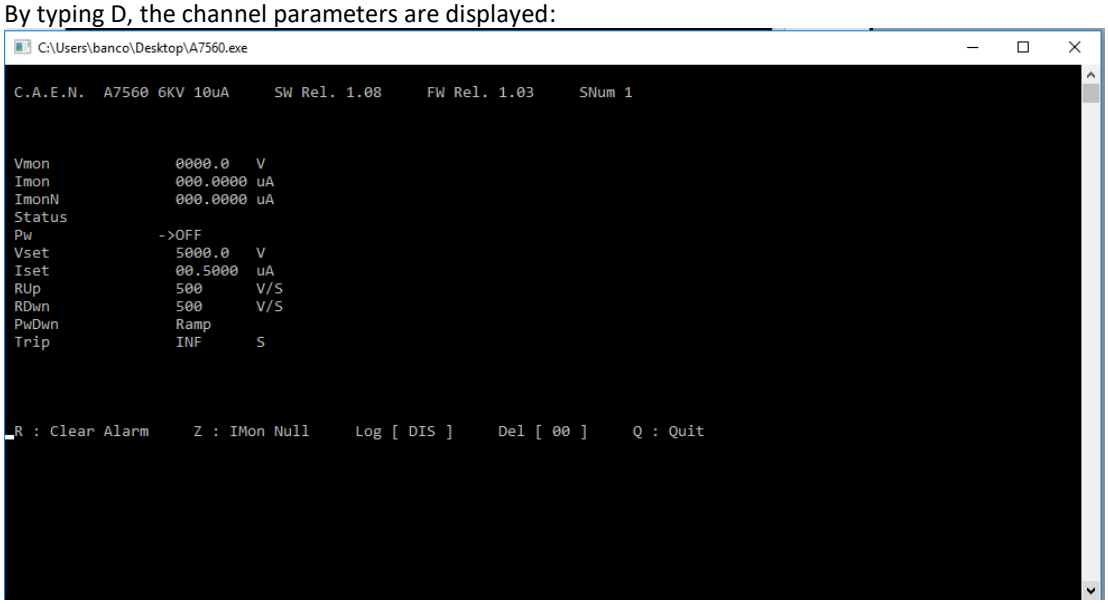
- Host PC
- Programmable power supply
- 5:12V USB to serial converter
- Serial to AMP adapter
- A7560

A7560 Operation

- Launch the A7560.exe program
- Turn ON the A7560 module via Enable bit
- Select the used USB port; Rate = 9600 baud, parity = none, Stop bit = 1
- the following menu will be displayed:



By typing D, the channel parameters are displayed:



Vmon, Imon, ImonN and Status are monitor parameters; Pw, Vset, Iset, Rup, Rdwn Pwdwn and Trip are set parameters

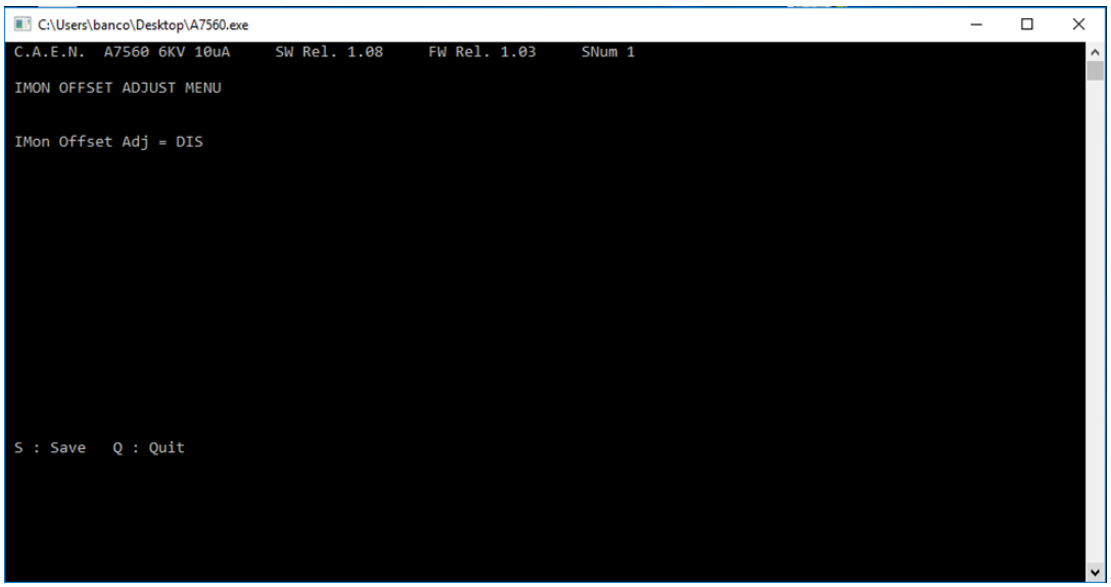
By typing Z, it is possible to access the IMon Offset adjustment; N.B. the zero adjustment regards only the monitored value; current protection is not adjusted.

To zero adjust, act as follows:

hit Z

space bar to toggle Imon Offset adj =enable/dis

before quit, save the configuration



In the Display menu, the Z option set to zero the Offset; the offset nulling can be performed at any working voltage.

To go back to the factory setting, without correction, go to menu Z and disable the Imon Offset adj.

The Display menu, allows also to access the Log menu, that allows to produce a text format log file. The "Del" command allows to set the data sampling (unit = seconds). The log file name is A7560 followed by module serial number. The Log option can be enabled and disabled via the Log command (see Display menu). The Log file will look like this:

A7560_SN3 -

File Modifica Formato Visualizza ?

```
12/05/2017 10.03.00 5998.4 1.2678 1.2548
12/05/2017 10.03.10 5998.4 1.2679 1.2550
12/05/2017 10.03.20 5998.4 1.2679 1.2548
12/05/2017 10.03.30 5998.4 1.2676 1.2547
12/05/2017 10.03.40 5998.4 1.2676 1.2546
12/05/2017 10.03.50 5998.4 1.2679 1.2549
12/05/2017 10.04.00 5998.2 1.2675 1.2546
12/05/2017 10.04.10 5998.2 1.2677 1.2548
12/05/2017 10.04.20 5998.2 1.2677 1.2548
12/05/2017 10.04.30 5998.2 1.2677 1.2551
12/05/2017 10.04.40 5998.2 1.2676 1.2549
12/05/2017 10.04.50 5998.2 1.2677 1.2549
12/05/2017 10.05.00 5998.2 1.2676 1.2548
12/05/2017 10.05.10 5998.1 1.2675 1.2548
12/05/2017 10.05.20 5998.1 1.2677 1.2550
12/05/2017 10.05.30 5998.1 1.2676 1.2550
12/05/2017 10.05.40 5998.1 1.2676 1.2552
12/05/2017 10.05.50 5998.1 1.2675 1.2550
12/05/2017 10.06.00 5998.1 1.2675 1.2549
12/05/2017 10.06.10 5998.0 1.2678 1.2552
12/05/2017 10.06.20 5998.0 1.2678 1.2552
12/05/2017 10.06.30 5998.0 1.2678 1.2553
12/05/2017 10.06.40 5998.1 1.2676 1.2552
12/05/2017 10.06.50 5997.9 1.2677 1.2553
```

Communication Protocol

The User can remotely control the A7560 PS module via a command interface protocol.
This protocol is based on commands made of ASCII character strings, through which the user can display/modify the value of all the channel parameters.

Command Format

All the commands sent to the A7560 PS module must have the following format :
$CMD:*,PAR:***,VAL:XXXXX<CR><LF>** where:
CMD: SET, MON
PAR: (see parameters table)
VAL: (numerical value must have a format compatible with resolution and range) Each string is terminated by CR(Carriage Return) and LF(Line Feed) characters

Format of Response String
The response strings sent from the A7560 module have the following format:

Format Response in Case of Error

#CMD:ERR<CR><LF>	Wrong command format or command not recognized
#PAR:ERR<CR><LF>	Field parameter not present or not recognized
#VAL:ERR<CR><LF>	Wrong set value(<Min, >Max)

Format Response in case of Correct Command

#CMD:OK<CR><LF>	Command OK
#CMD:OK,VAL:*<CR><LF>	Command OK; *= value sent back from module to received command

Numerical **'VAL'** field has a value compatible with range and resolution

Set Commands

$CMD:SET, PAR:ON<CR><LF>	Channel Power ON Command
$CMD:SET, PAR:OFF<CR><LF>	Channel Power OFF Command
$CMD:SET, PAR:VSET,VAL:XXXXX<CR><LF>	Set Channel Voltage Set Point value (*)
$CMD:SET, PAR:ISET,VAL:XXXXX<CR><LF>	Set Channel Current Set Point value (**)
$CMD:SET, PAR:CLR<CR><LF>	Clear Channel Trip Time Alarm
$CMD:SET, PAR:PDWN,VAL:RAMP<CR><LF>	Set 'RAMP' as channel Power Down Mode
$CMD:SET, PAR:PDWN,VAL:KILL<CR><LF>	Set 'KILL' as channel Power Down Mode
$CMD:SET, PAR:RUP,VAL:XXX<CR><LF>	Set Channel Rump Up Time
$CMD:SET, PAR:RDW,VAL:XXX<CR><LF>	Set Channel Rump Down Time
$CMD:SET, PAR:TRIP,VAL:XXXXX<CR><LF>	Set Channel Trip Time (***)
$CMD:SET,PAR:IMZEN,VAL:EN<CR><LF>	Enable IMon Offset Compensation
$CMD:SET,PAR:IMZEN,VAL:DIS<CR><LF>	Disable IMon Offset Compensation
$CMD:SET,PAR:IMZERO,VAL:1<CR><LF>	Compensate IMon Offset

(*)
VSet value must be send to A7560 module as an unsigned 16 bit integer rounded to VSet resolution
VSRES : VSet = (uint16)(fval * (float)VSRES + 0.5)
fval = voltage set point [Volt]
VSRES = VSet Resolution [DAC count/Volt], being VSRES = 10 (consider 16 bit DAC and

VMAX = 6000V)
(**)
ISet value must be send to A7560 module as an unsigned 16 bit integer rounded to ISet resolution
ISRES : ISet = (uint16)(fval * (float)ISRES + 0.5)
fval = current set point [uA]
ISRES = ISet Resolution [DAC count/µA], being ISRES = 5000 (consider 16 bit DAC and IMAX = 500µA)
(***)
Trip Time value value must be send to A7560 module as an unsigned 16 bit integer rounded to ISet resolution TRIPRES : Trip = (uint16)(fval * (float)TRIPRES + 0.5)
fval = trip value [sec]
TRIPRES = TRIP resolution[sec^{-1}]

Monitor Commands

$CMD:MON,PAR:STAT<CR><LF>	Read out the channel status value (*)
$CMD:MON,PAR:VSET<CR><LF>	Read out VSet * VSRES (16 bit unsigned integer)
$CMD:MON,PAR:ISET<CR><LF>	Read out ISet * ISRES (16 bit unsigned integer)
$CMD:MON,PAR:VMON<CR><LF>	Read out VMon * VMRES (16 bit unsigned integer)
$CMD:MON,PAR:IMON<CR><LF>	Read out Positive Current : IMon * IMRES value (24 bit unsigned integer)
$CMD:MON,PAR:NIMON<CR><LF>	Read out Negative Current : NIMon * IMRES value (24 bit unsigned integer)
$CMD:MON,PAR:VSMAX<CR><LF>	Read Out VSMAX : VSMAX = VMAX*VSRES
$CMD:MON,PAR:ISMAX<CR><LF>	Read Out ISMAX : ISMAX = IMAX*ISRES
$CMD:MON,PAR:VMAX<CR><LF>	Read out VSet maximum value [Volt]
$CMD:MON,PAR:IMAX<CR><LF>	Read out ISet maximum value[uA]
$CMD:MON,PAR:VSRES<CR><LF>	Read out VSet resolution[1/Volt]
$CMD:MON,PAR:ISRES<CR><LF>	Read out ISet resolution[1/uA]
$CMD:MON,PAR:VMRES<CR><LF>	Read out VMon resolution[Volt]
$CMD:MON,PAR:IMRES<CR><LF>	Read out IMon resolution[uA]
$CMD:MON,PAR:TRIPRES<CR><LF>	Read out the trip resolution [1/s]
$CMD:MON,PAR:TRIP<CR><LF>	Read out the Trip * TRIPRES (16 bit unsigned integer)
$CMD:MON,PAR:TRIPMAX<CR><LF>	Read out trip time maximum value [s]
$CMD:MON,PAR:RAMPMAX<CR><LF>	Read out maximum Rump time[V/s]
$CMD:MON,PAR:RAMPMIN<CR><LF>	Read out minimum Rump time[V/s]
$CMD:MON,PAR:NAME<CR><LF>	Read Out Module Name
$CMD:MON,PAR:FREL<CR><LF>	Read Out Firmware Release

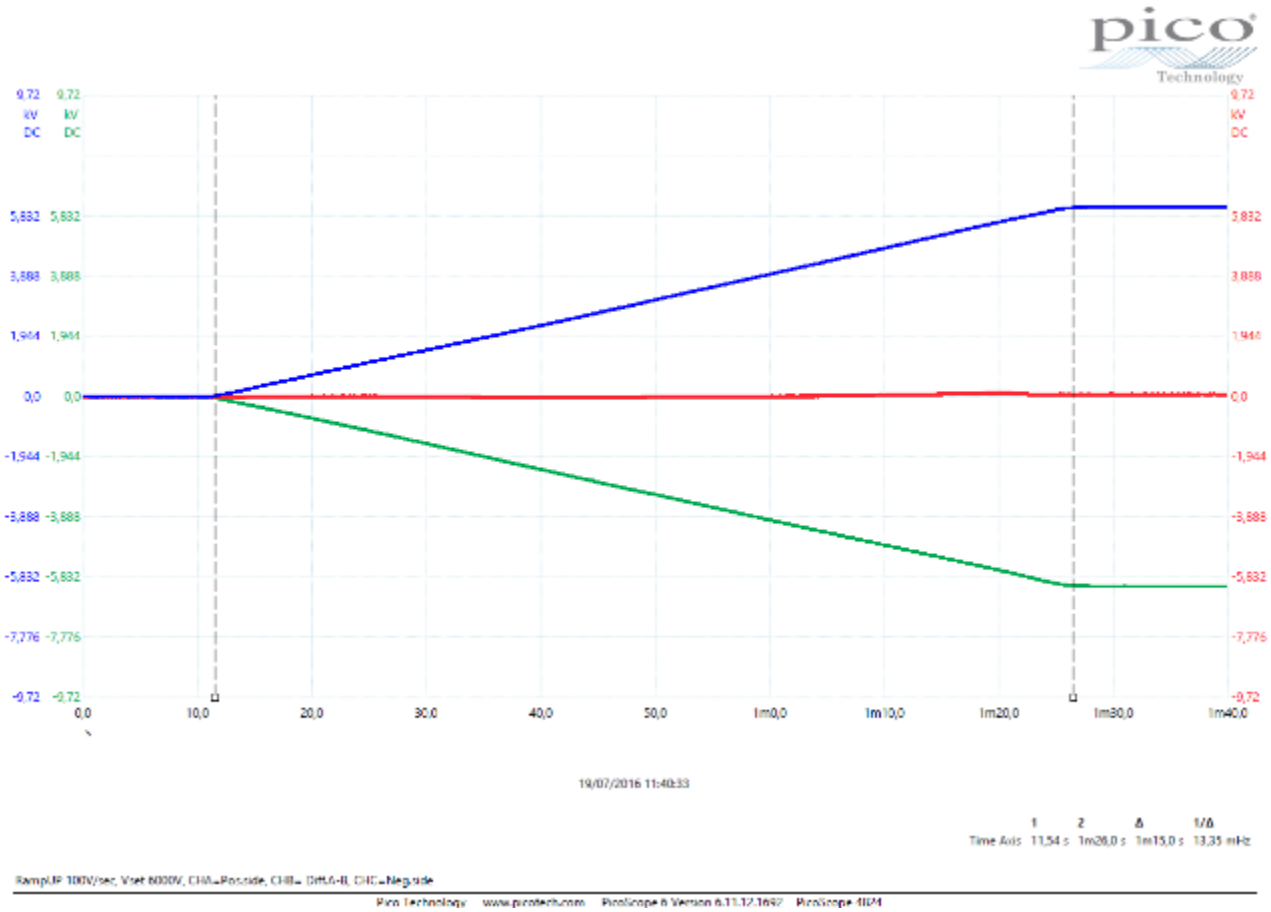
(*)
Response String -> #CMD:OK,VAL:<value><CR><LF>

Meaning of Status Bits :

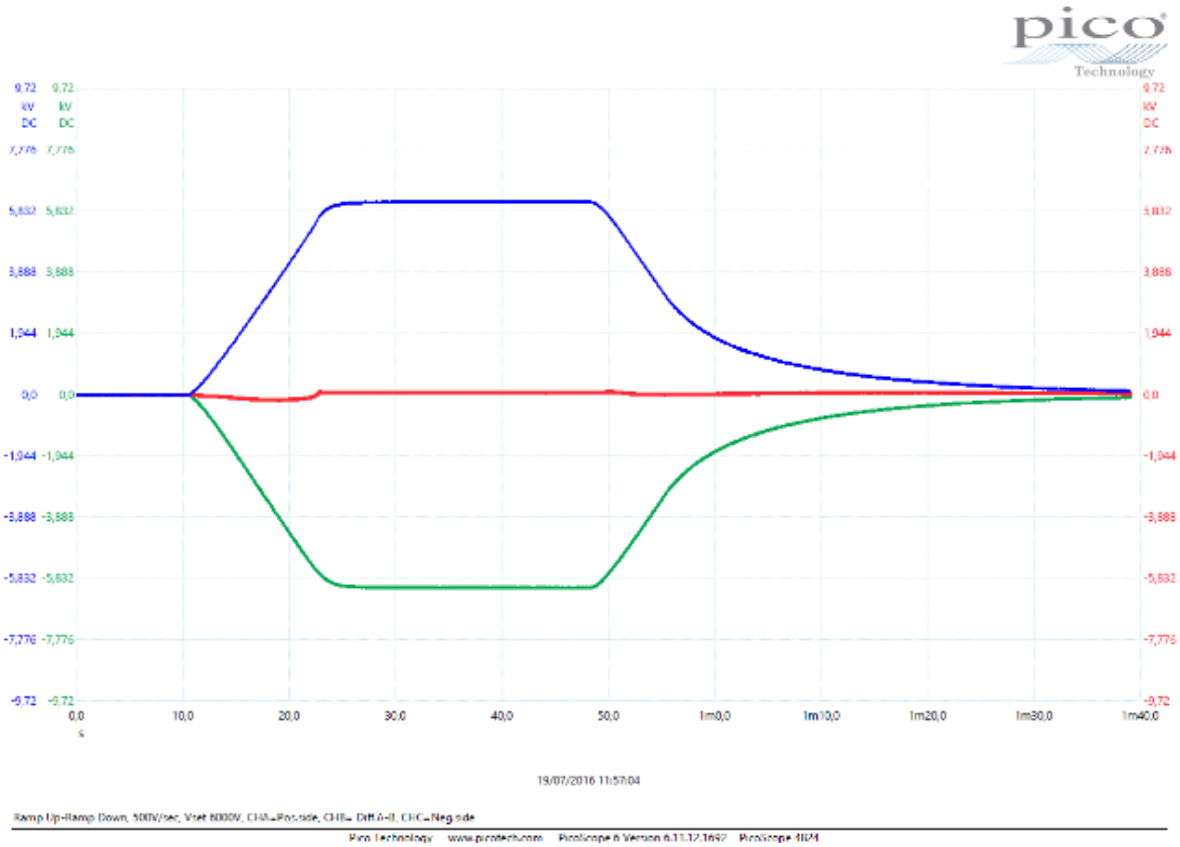
Bit 0 -> IS_ON	1: Channel is ON ; 0:Channel is OFF
Bit 1 -> IS_UP	1: Channel is ramping Up
Bit 2 -> IS_DOWN	1: Channel is ramping down
Bit 3 -> IS_OVC	1: Channel is in Over Current
Bit 4 -> IS_TRIP	1: Channel is in Trip

Screen Samples

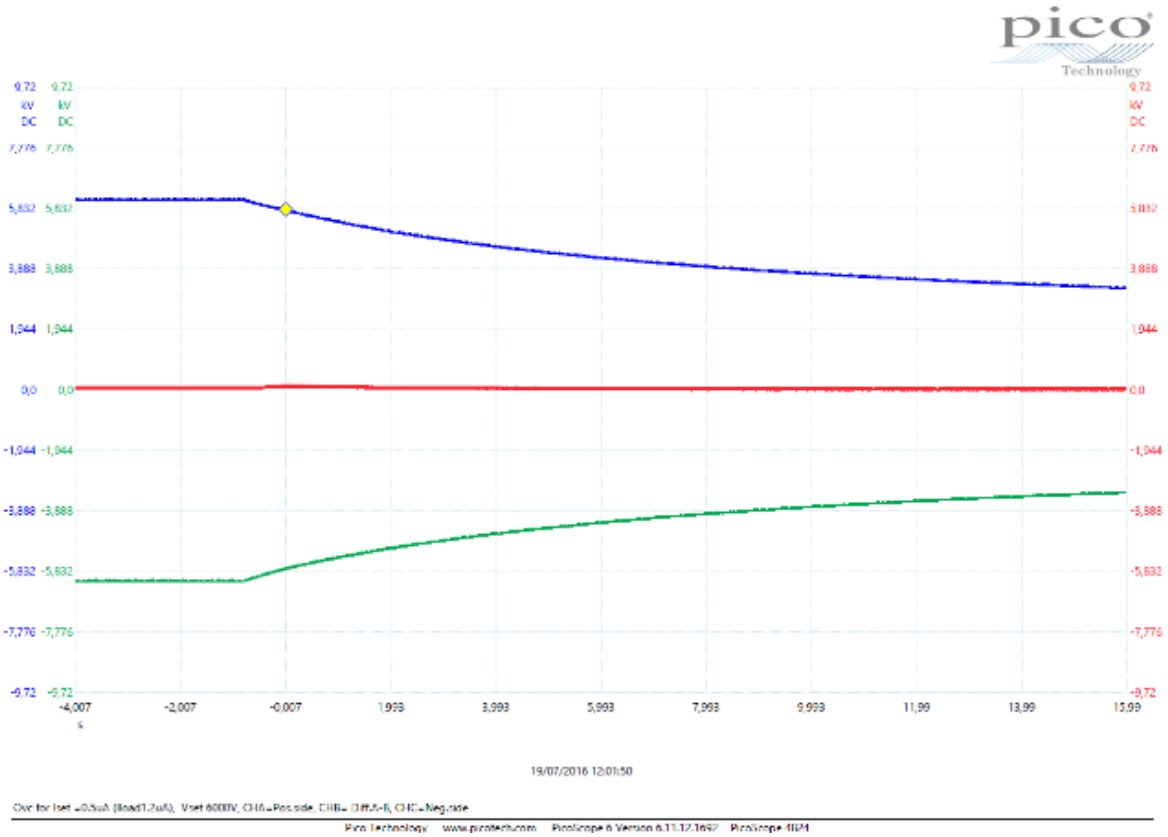
The following screen samples will show some working conditions:



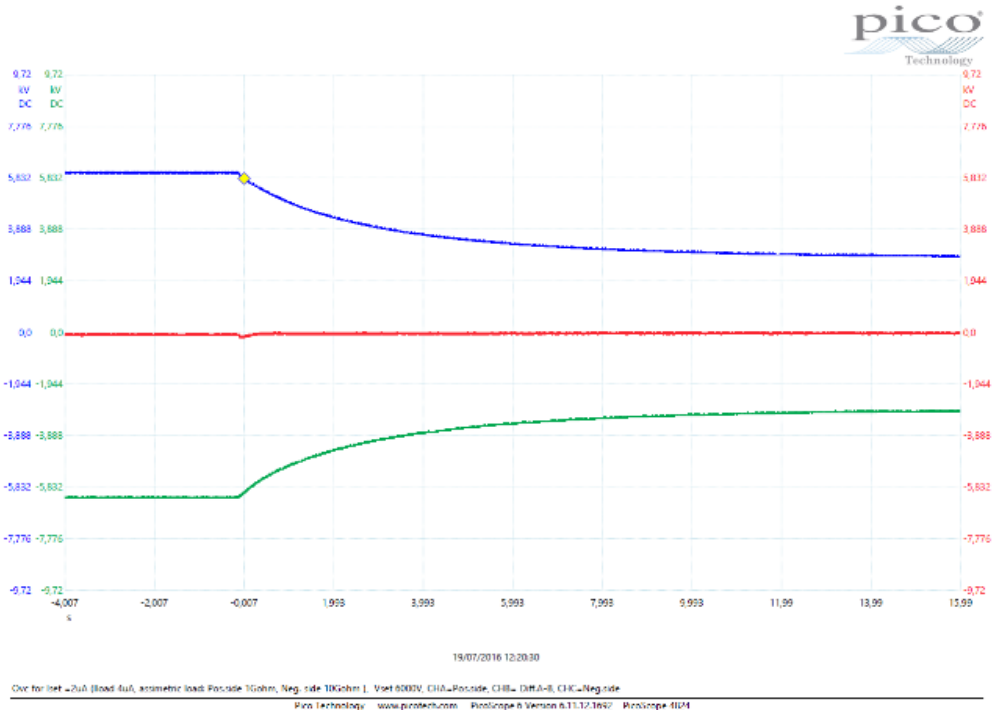
- Blue trace: HV channel positive side.
- Green trace: HV channel negative side.
- Red trace: difference between positive and negative; worst case is 4% of full scale. Delta between positive and negative rail remains within Vset vs. Vout accuracy.



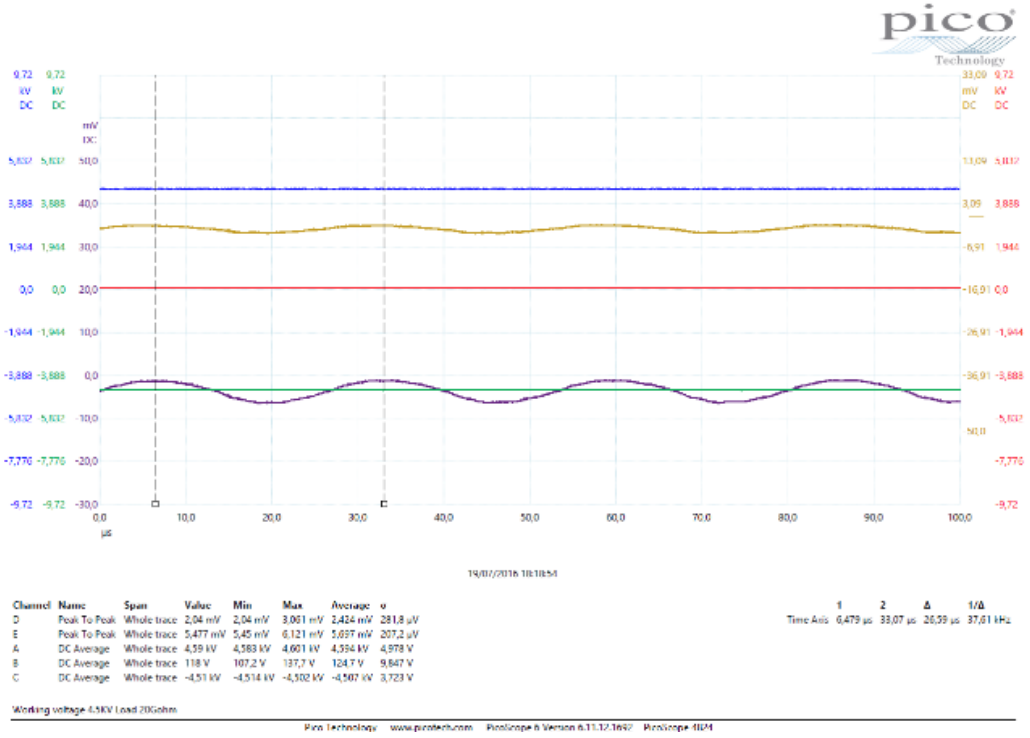
Turning ON/OF sequence with 500V/s ramps



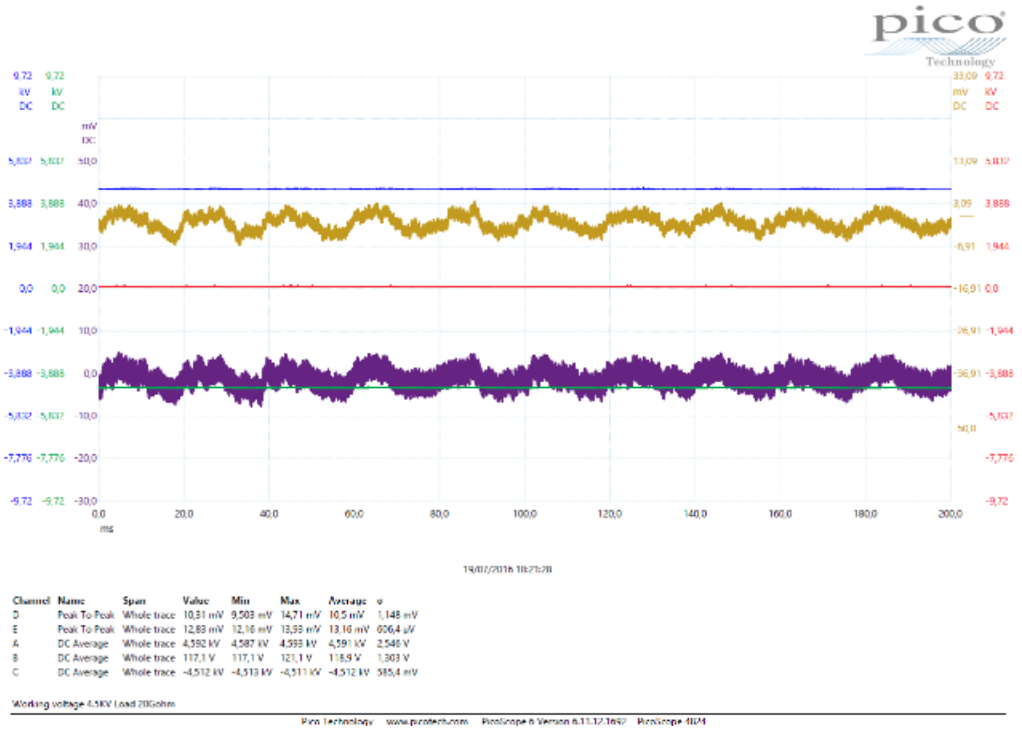
OVC response with Iset = 0.5µA, operating current 1.2µA, symmetrical load on both sides



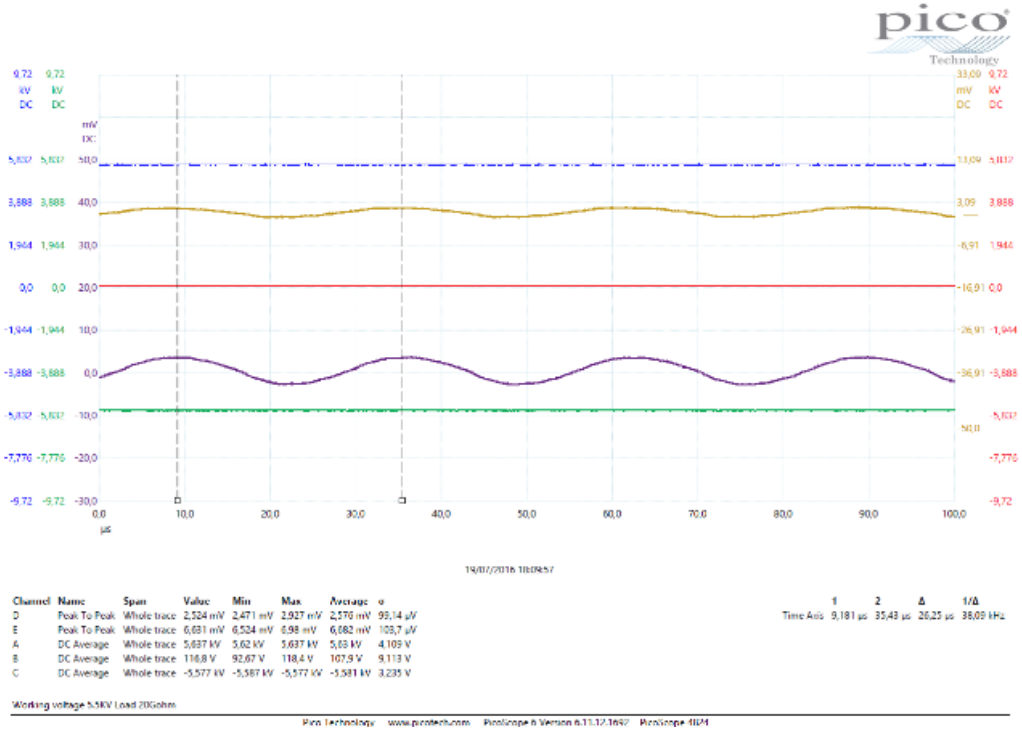
OVC response with Iset = 2µA, operating current 4µA, asymmetrical load (positive: 1 GOhm, negative: 10GOhm)



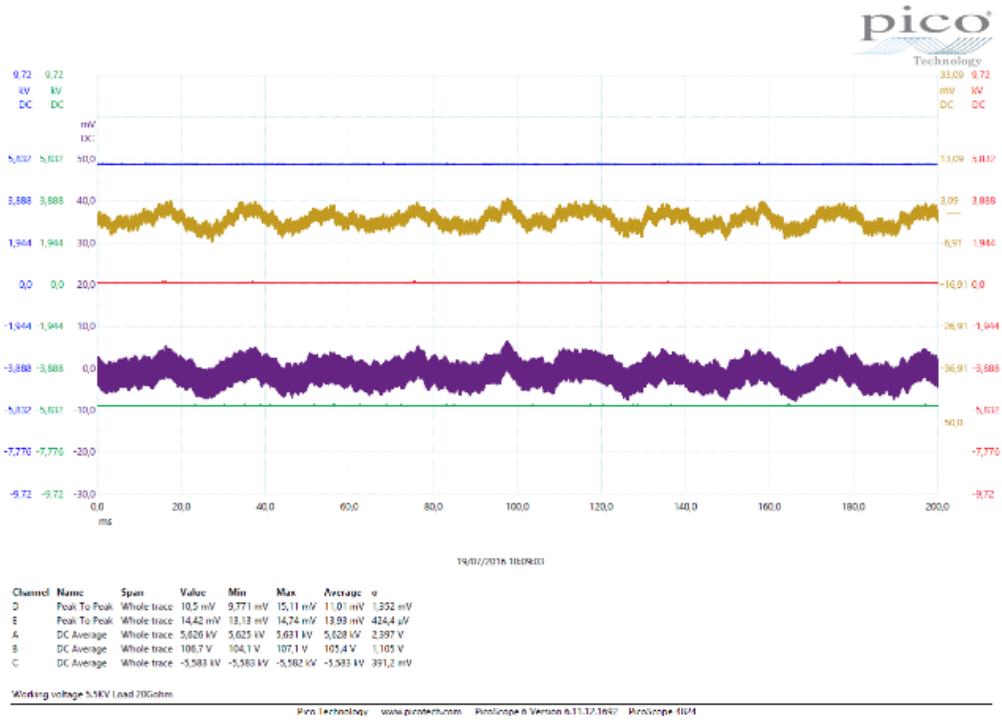
Rail voltage and ripple for Vset=+4.5kV at switching frequency



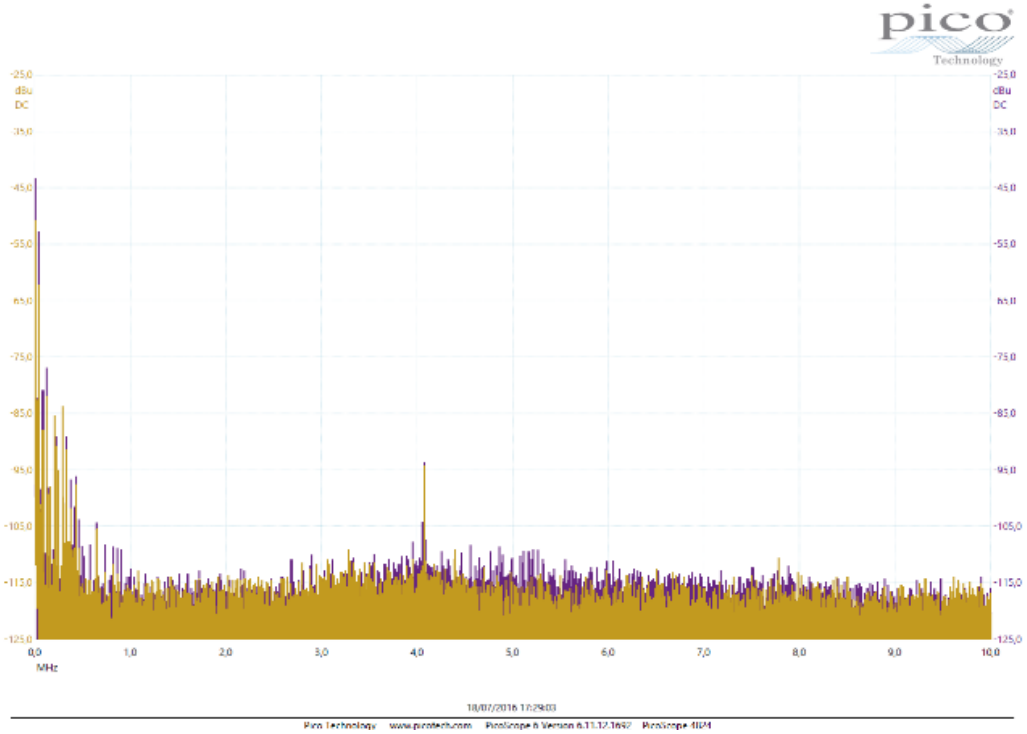
Rail voltage and ripple for Vset=+4.5kV at low frequency



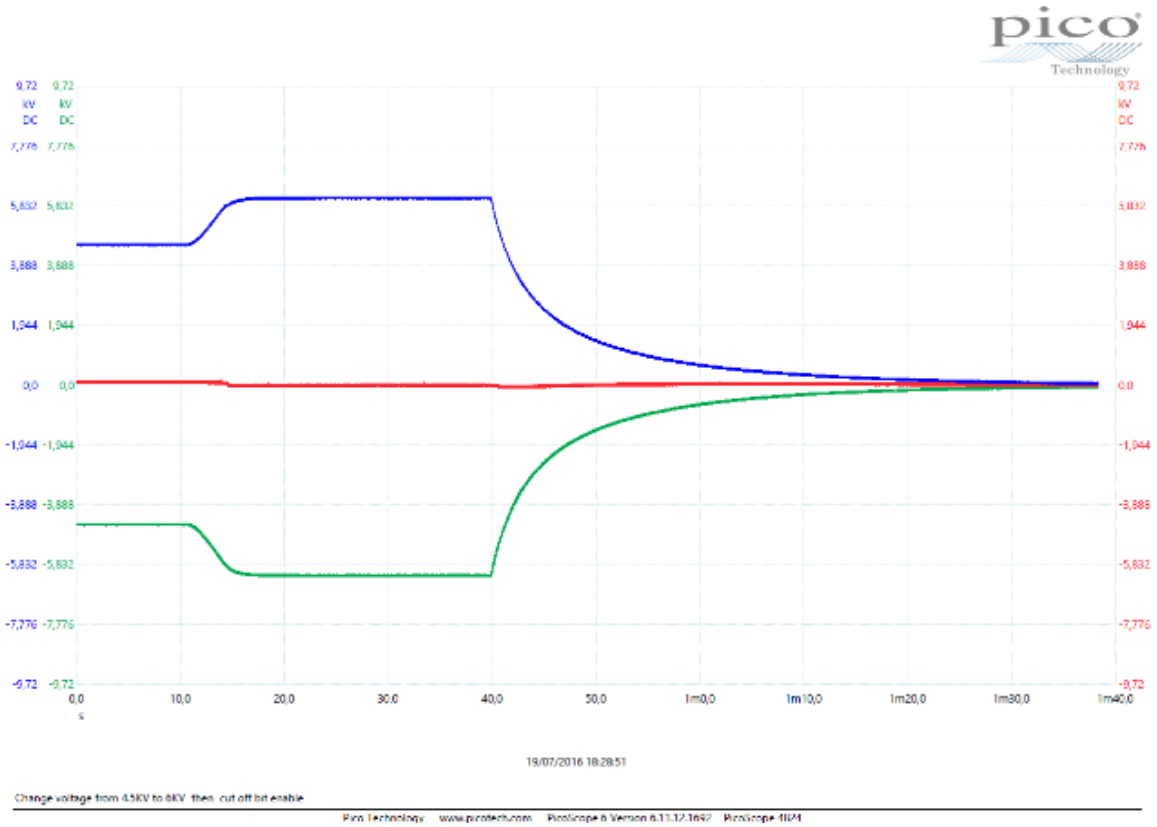
Rail voltage and ripple for Vset=+5.5kV at switching frequency



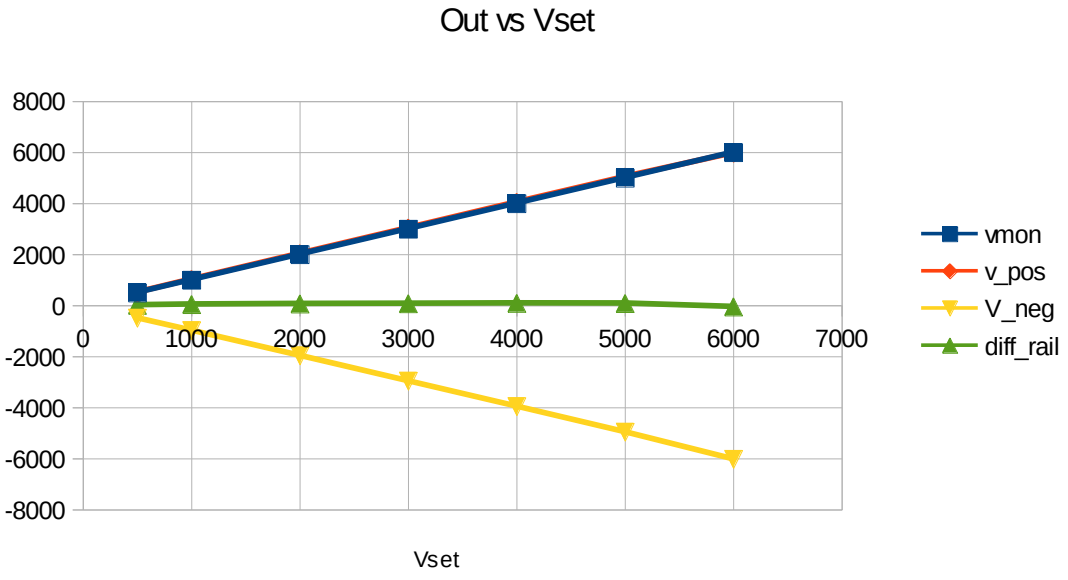
Rail voltage and ripple for Vset=+5.5kV at low frequency



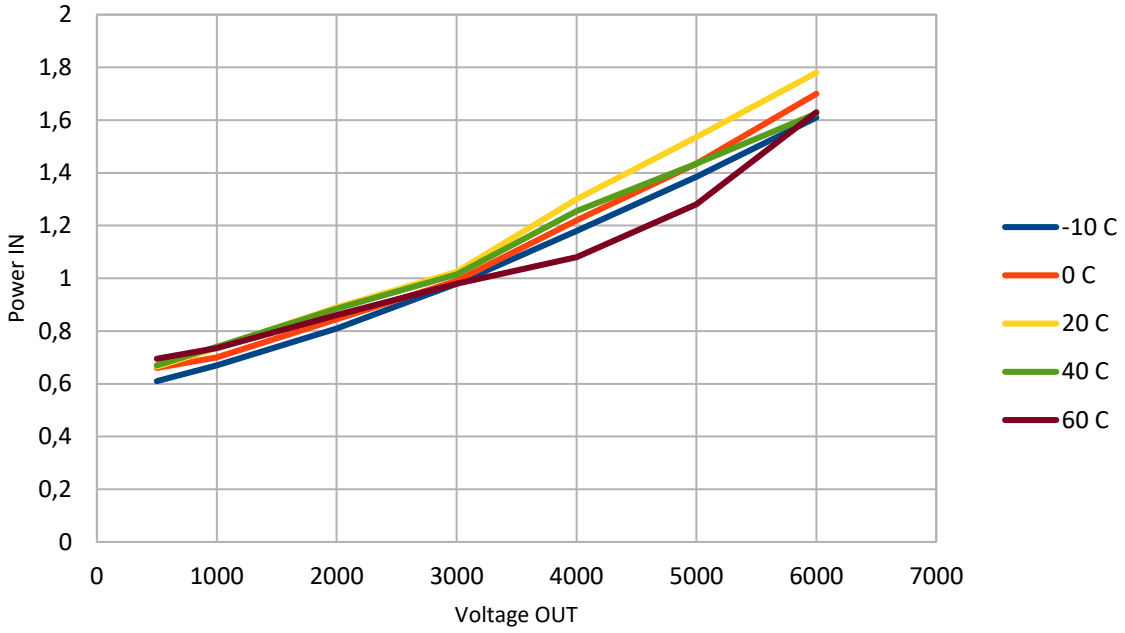
Noise distribution at 4.5kV



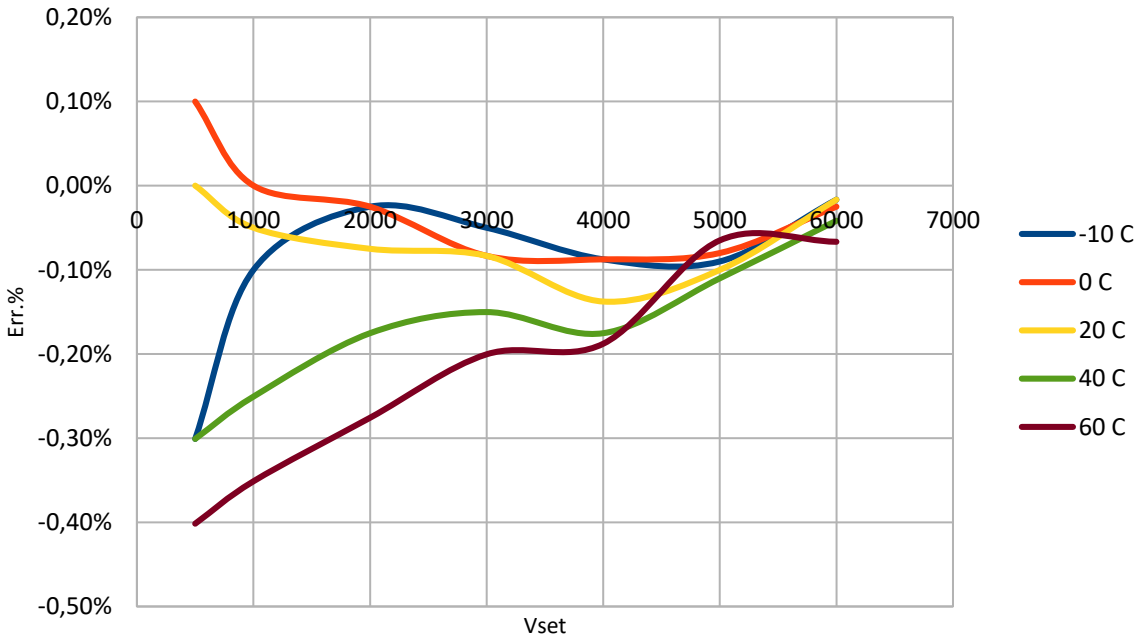
Channel response upon Vset increase and cut-off via Enable bit



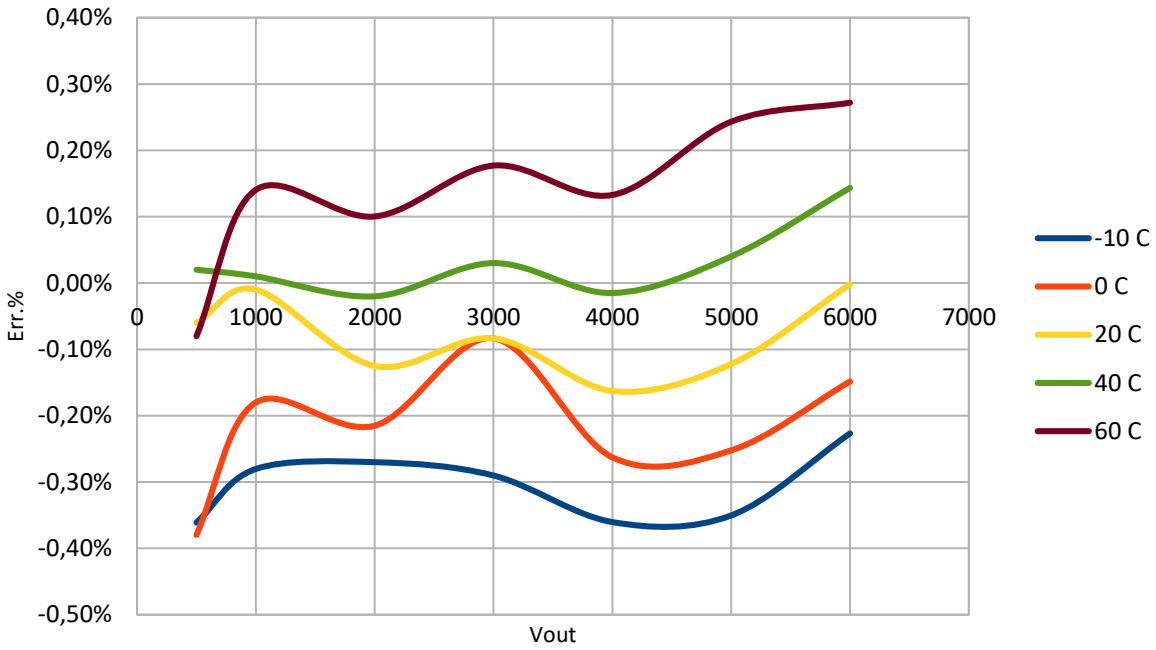
Rail voltages: Positive, Negative, Monitor, difference



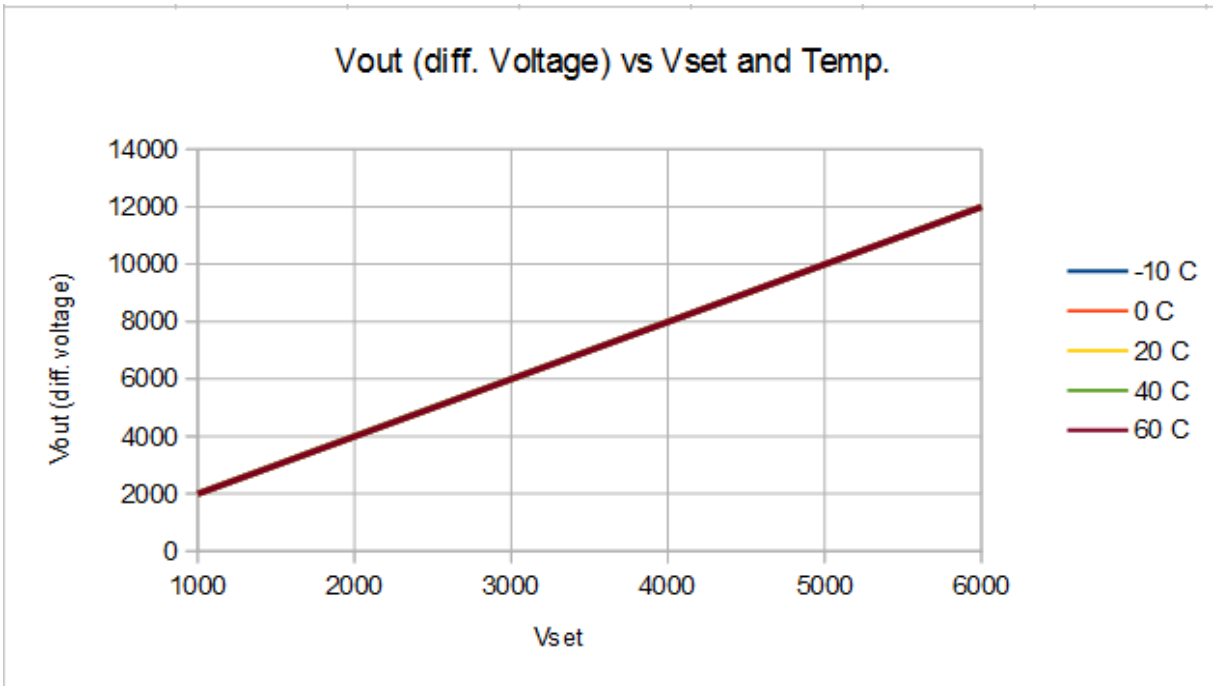
Power IN Vs. Vout and Temperature (1 GOhm load for rail)



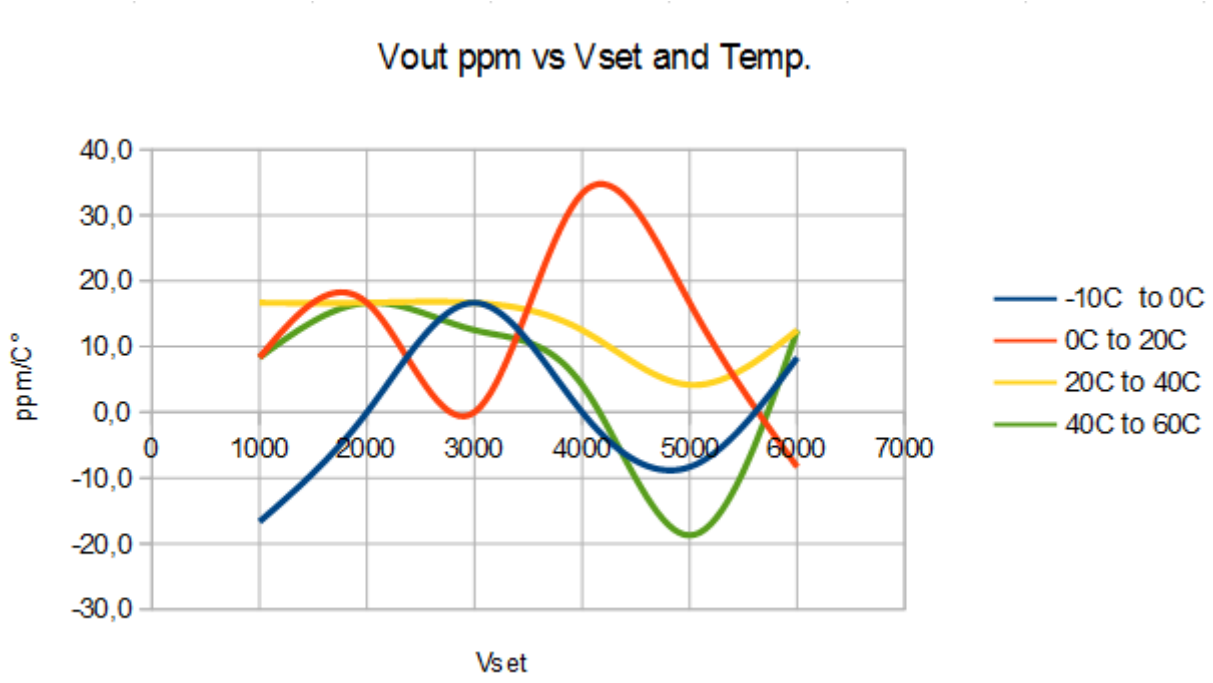
Vout % Error Vs. Vset



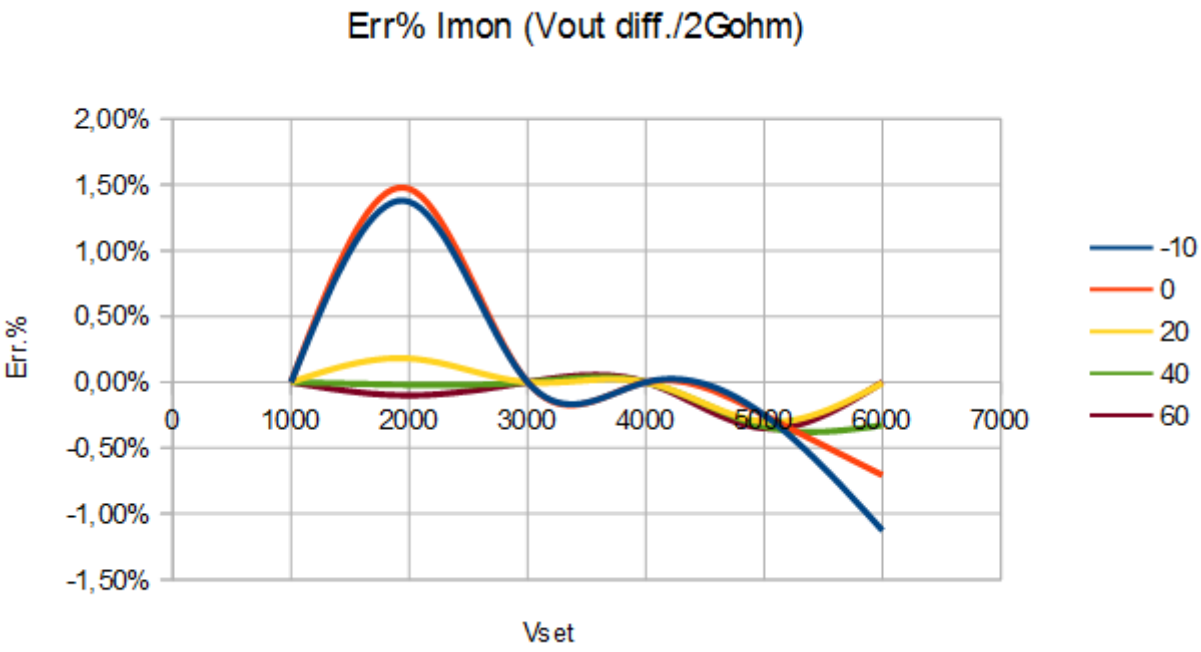
Vout % Error Vs. Vmon



Vout (differential Voltage) vs Vset and Temperature (same characteristic for Temperature values -10 ÷ 60 °C)



Vout ppm Vs. Vset and Temperature



Imon % Error Vs. Vset

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