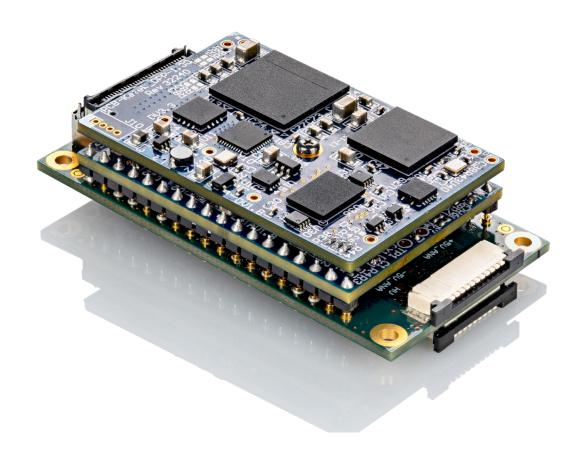
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VICO-AV 2.0 VICO-DV 2.0

**Manual** 







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This manual covers the KETEK VICO-DV 2.0 (s/n DV2xxxx) and VICO-AV 2.0 (s/n AV2xxxx) products only. For other products please refer to other documents available on our website https://www.ketek.net/documentation/sdd-downloads.



Dear Customer,

Thank you for choosing the KETEK VICO-DV 2.0/AV 2.0 system. We ensure you that this product has been developed and manufactured with highest industry standards in order to meet your quality expectations. Our highest priority is to deliver you the best product on the market.

### 1 Safety and Warranty

#### 1.1 Cautions and Warnings

It is strongly recommended to read this user manual carefully and completely before installing or activating the device. Please keep this user manual always with the system to allow any operator access to this important information. In case of a potential resale or scrapping of the system at the end of its lifetime, this manual should be given along with the device.



This device generates a high voltage during the operation.

DO NOT TOUCH the board or the connectors when powered on.



Follow the cautions and warnings listed below to avoid injuries and warranty loss.



Make sure that only properly trained staff installs and operates the VICO-DV 2.0/AV 2.0 and any equipment in which the device will be operated.



To prevent an electrical shock, make sure that energized contacts (PCB, flex connection, etc.) are not accessible during operation (finger-safe).



Make sure that energized contacts (PCB, flex connection, etc.) cannot be mechanically damaged.



The KETEK VICO-DV 2.0/AV 2.0 must only be operated as an integrated element inside the housing of the customer's final instrument.



Scrapping of a VICO-DV 2.0/AV 2.0 device at end of its lifetime has to be done according to the country-specific legal regulations.



Repair or maintenance of the VICO-DV 2.0/AV 2.0 must be performed by KETEK only. Any violation leads to the loss of the product warranty.



Keep the device dry and clean!



Please notice that the devices are not designed to be operated under vacuum conditions.



This unit fulfills the EMI safety standards as a standalone device and is considered a component which will be installed into a final equipment. The final equipment must be reconfirmed that it still meets the EMC directives.



Be aware of the danger of hot surfaces, as some parts of the system will get hot during operation.



### 1.2 Warranty

KETEK GmbH warrants to the original purchaser this instrument to be free from defects in materials and workmanship for a period of one year from shipment. KETEK GmbH will, without charge, repair or replace (at its option) a defective instrument upon return to the factory. This warranty does not apply in the event of misuse or abuse of the instrument or unauthorized alterations or repair. KETEK GmbH shall not be liable for any consequential damages, including without limitation, damages resulting from the loss of use due to failure of this instrument. All products returned under the warranty must be shipped prepaid to the factory with documentation describing the problem and the circumstances under which it was observed. Additionally, the statement of contamination must be filled out completely and returned with the product. KETEK GmbH must be notified prior to return shipment. The instrument will be evaluated, repaired or replaced, and promptly returned if the warranty claims are substantiated. A nominal fee will be charged for unsubstantiated claims. Please include the model and serial number in all correspondence with KETEK GmbH.

#### 2 Intended Use

The KETEK VICO-DV 2.0/AV 2.0 is intended for integration inside the housing of the customer's final instrument to operate the KETEK VIAMP module. It is not intended for stand-alone operation.

After integration, the energized contacts (PCB, flex connection, etc.) shall not be accessible during operation (finger-safe). For best spectroscopic performance proper shielding of the VICO-DV 2.0/AV 2.0 inside the final instrument is recommended.

The VICO-DV 2.0/AV 2.0 is not designed to be operated under vacuum conditions.



### **3 Product Description**

The KETEK VICO-DV 2.0/AV 2.0 OEM system is designed for operation with the KETEK VIAMP module only. Two product variants are available: one for operating an SDD based VIAMP the other one for operating of a PIN replacement-type SDD.

The device comprises a high-performance digital pulse processor, temperature controller, and high voltage supply for the VIAMP and can be used with VIAMP including improved cooling technology SDDs with Graphene window.

- The VICO-DV 2.0 contains the KETEK VICO-DP digital pulse processor. It is the digital variant of the featured OEM system. The digital output (complete spectrum) is accessible via USB or RS-232 interface. Moreover, the analog output is also available (ramped reset type).
- The VICO-AV 2.0 is the analog variant without the VICO-DP. Only the analog output (ramped reset type) is available.

#### 3.1 Ordering information

Part number	Description	Picture
EVICO-AV_2.0	VICO-AV 2.0 (analog) for SDD and PIN-SDD VIAMP	
EVICO-DV_2.0	VICO-DV 2.0 (digital) for SDD VIAMP	
EVICO-DV_2.0_PIN	VICO-DV 2.0 (digital) for PIN-SDD VIAMP (optimized DPP parameters for PIN-SDD, same hardware as EVICO-DV_2.0)	The state of the s

To connect the VICO-DV 2.0/AV 2.0 and the KETEK VIAMP, two FFC cables (8- and 10-pole) are required. Cable sets in different lengths are available:

Part number	Description
E-FFC-08P_051	FFC connection cable, 51 mm,
E-FFC-10P_051	8- and 10-pole respectively
E-FFC-08P_102	FFC connection cable, 102 mm,
E-FFC-10P_102	8- and 10-pole respectively
E-FFC-08P_152	FFC connection cable, 152 mm,
E-FFC-10P_152	8- and 10-pole respectively
E-FFC-08P_200	FFC connection cable, 200 mm,
E-FFC-10P_200	8- and 10-pole respectively



Useful accessories for the first test (Please note: available for sampling only):

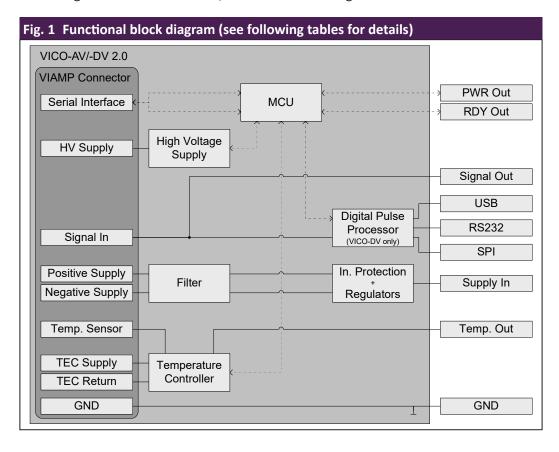
Part number	Description	Picture
EVICO-XV-ADAPTER-S	Small breakout board for VICO-DV 2.0/AV 2.0 connectors: V_IN, USB, SIG, TEMP, LEDs	
EVICO-XV-ADAPTER-L	Large breakout board for VICO-DV 2.0/AV 2.0 connectors: V_IN, USB, SIG, TEMP, LEDs, RS232, SPI, LAN, JTAG, PDI	
EVICO-XV-SHIELD_THRD	Shield plate	
APS-GE24I05-P1J	Power supply for VICO-DV 2.0/AV 2.0, Mean Well GE24I05-P1J 5VD-C/3A Power Jack	
APS-GE24I_ACPLUG-MIX	AC plug-MIX for APS-GE24I05-P1J with AU, EU, UK and US type	

#### 3.2 Features

- Extremely small dimensions 60 x 32 x 17 mm<sup>3</sup>
- Access to analog preamplifier signal and SDD temperature monitor
- Very low typical power consumption < 2 W
- Wide unipolar voltage input range: +5 VDC to +12 VDC
- USB 2.0, SPI and RS232 interfaces
- SDD operating temperature setting, spectrum readout and power saving modes accessible via software.



The functional block diagram of the VICO-DV 2.0/AV 2.0 is shown in Fig. 1.





## 4 Specifications

Tab. 1 Environmental Requirements			
Characteristics	Specification	Note	
Operating Temperature Range	0 °C to +50 °C	_	
Storage Temperature Range	-30 °C to +80 °C	-	
Operating Humidity Range	5 to 80 %	Non-condensing	
Vibration test	Acc. to EN 60068-2-27	Approved	

Tab. 2 General information	i e	
Characteristics	Specification	Note
Outline dimensions	60 x 32 x 17 mm <sup>3</sup>	Drawings in sections 4.5 and 4.6
Weight	30.8 g (14.5 g VICO-AV)	-
RoHS compliant	Yes	2011/65/EU incl. 2015/863/EU
EMC requirements	Acc. to EN 61326-1: 2013	See appendix in chapter 8
Digital interfaces	USB 2.0, RS232, SPI	-

Tab. 3 Required power supply and stability			
Parameter	Specification		Note
Input voltage range	+5 to +12 VDC ± 10 %		_
		Example 1	for 5 VDC:
Line Voltage Regulation	±1%		_
Load Voltage Regulation	±5 %		_
Voltage Ripple	50 mV <sub>p-p</sub>		-

Tab. 4 VICO-DV 2.0 electrical parameters for +5 VDC		
Parameter	Typ. rating*	Max. rating**
Current	440 mA	1000 mA
Dissipation loss	1880 mW	2340 mW

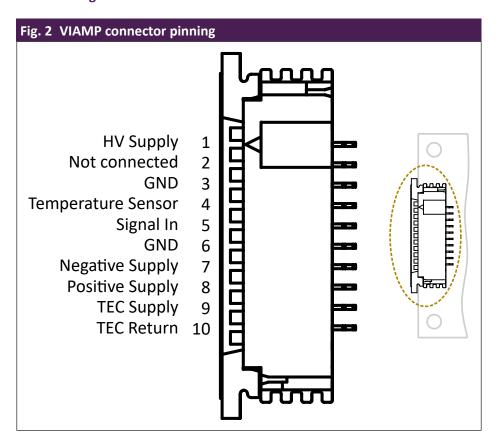
Tab. 5 VICO-AV 2.0 electrical parameters for +5 VDC		
Parameter	Typ. rating <sup>*</sup>	Max. rating**
Current	185 mA	730 mA
Dissipation loss	600 mW	950 mW

 $<sup>^{*}</sup>$  Measured at +20 °C housing bottom side temp. of VIAMP module, -35 °C SDD chip temp., steady state  $^{**}$  Max. rating values reached for few seconds after powering on or full thermal load



### 4.1 VICO-DV 2.0/AV 2.0 I/O Connectors

#### **4.1.1 VIAMP Connector Pinning**

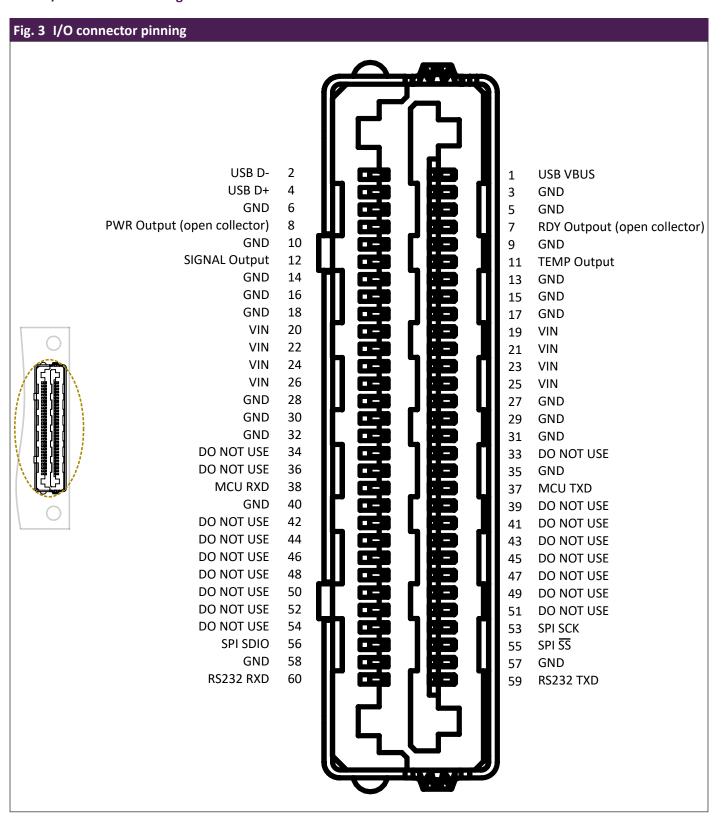


#### 4.1.2 VIAMP Connector Pin Description

Pin #	Name	Туре	Description	Note
1	HV Supply	Out	SDD BIAS voltage	Typical: -168 VDC
2	Not connected	_	-	-
3	GND	Pas	Ground	_
4	Temperature Sensor	In	Thermistor input	-
5	Signal In	In	Ramp signal input from VIAMP	Identical with SIGNAL Output of I/O connector
6	GND	Pas	Ground	_
7	Negative Supply	Out	VIAMP - 5 VDC supply	_
8	Positive Supply	Out	VIAMP +5 VDC supply	_
9	TEC Supply	Out	TEC supply	_
10	TEC Return	Pas	TEC Return	-



#### 4.1.3 I/O Connector Pinning





### 4.1.4 I/O Connector Pin Description

Tab. 7	I/O Connector Pin Descript	ion		
Pin #	Name	Туре	Description	Note
1	USB VBUS	In	USB supply	-
2	USB D-	1/0	USB Data-	-
3	GND		Ground	-
4	USB D+	1/0	USB Data+	-
56	GND		Ground	-
7	RDY Output		-	Low/GND: Set chip temperature reached
	(open collector)			High/open: Set chip temperature not reached
8	PWR Output		_	Low/GND: Powered up
	(open collector)			High/open: Diagnostic in progress or error
910	GND		Ground	_
11	TEMP Output	Out	SDD temperature monitor	Load resistance ≥ 1 MΩ
	TENNI Gatpat	Out	322 temperature momeor	current ≤ 1 mA
12	SIGNAL Output	Out	Analog signal output	Load resistance $\geq$ 10 k $\Omega$ Identical with Signal In of VIAMP connector Note: during power-up initalization (1.5 sec.) this singal reaches +3 V
1318	GND		Ground	_
1926	VIN	In	DC input	+5 to +12 VDC
2732	GND		Ground	-
3334	DO NOT USE		N/A	-
35	GND		Ground	_
36	DO NOT USE		N/A	-
37	MCU TXD	Out	Debug interface	0 to +3.3 VDC
38	MCU RXD	In	Debug interface	0 to +3.3 VDC
39	DO NOT USE		N/A	_
40	GND		Ground	-
4152	DO NOT USE		N/A	_
53	SPI SCK	In	Serial clock	Input low: -0.5 to +0.8 V Input high: +2 to +4.1 V
54	DO NOT USE		N/A	_
55	SPI <del>SS</del>	In	Slave select	Input low: -0.5 to +0.8 V
56	SPI SDIO	I/O	Serial data I/O	Input high: +2 to +4.1 V Output low maximum: +0.4 V Output high minimum: +2.9 V
5758	GND		Ground	-
59	RS232 TXD	Out	UART send	-5 to +5 VDC
				Voltage swing: min. ±5 VDC typ. ±5.4 VDC
60	RS232 RXD	In	UART receive	min. ±2.7 VDC max. ±25 VDC



### **4.2 Connector Types**

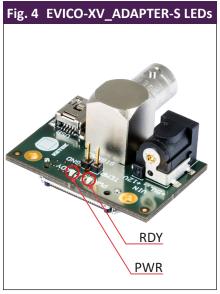
Tab. 8 (	Tab. 8 Connectors and contacts													
Name	Connector Type	Mating connector (examples)	Note											
VIAMP	TE connectivity 1-84953-0	FFC 10-pos, 1 mm	ZIF contact upper side,											
	TE connectivity 84953-8	FFC 8-pos, 1 mm	unshielded, only compatible with KETEK VIAMP series											
1/0	LSHM-130-06.0-L-DV-A-S-K-TR	LSHM-130-02.5-L-DV-A-S-K-TR LSHM-130-03.0-L-DV-A-S-K-TR LSHM-130-04.0-L-DV-A-S-K-TR LSHM-130-06.0-L-DV-A-S-K-TR	_											

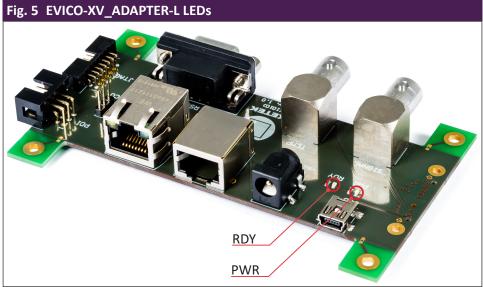
### 4.3 VICO-DV 2.0/AV 2.0 Developer's Starter Kit

For a quick and easy setup of the VICO-DV 2.0/AV 2.0 KETEK offers a Developer's Starter Kit consisting of a breakout board, a shield plate and a power supply as shown in Fig. 6 and Fig. 7. This allows the first tests of the VICO-DV 2.0/AV 2.0 before designing your own breakout board or starting with the integration into your system. The breakout board is available in two versions to meet all requirements:

- A small breakout board with connectors V\_IN (power supply input), USB (USB interface), SIG (analog output signal), TEMP (analog chip temperature readout). EVICO-XV\_ADAPTER-S shown in Fig. 4.
- Or a large breakout board with the same connector as the small one and additionally the following connectors: RS232 (serial interface) and SPI (SPI interface). EVICO-XV ADAPTER-L shown in Fig. 5.

LEDs indicate, if the power is switched on (PWR LED) and the system has reached the correct operating temperature (RDY LED) as shown in Fig. 4 and Fig. 5.



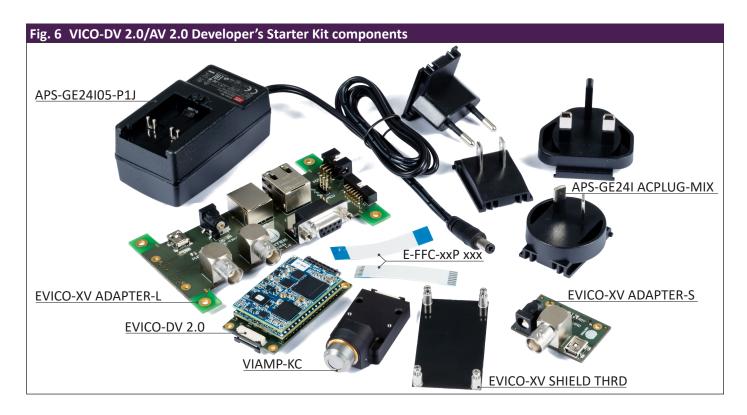


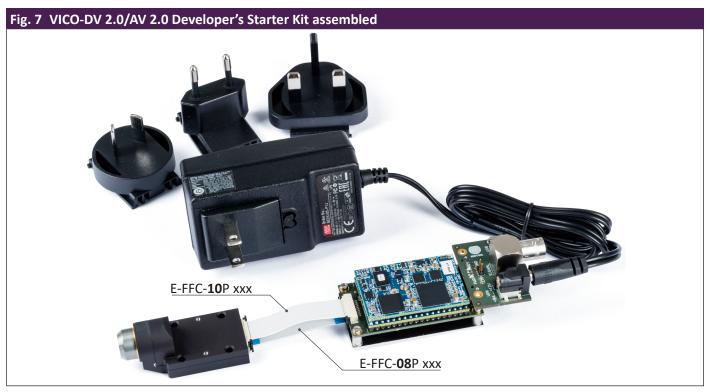


Proper shielding is necessary to achieve an excellent spectroscopic performance with the VICO-DV 2.0/AV 2.0 which has to be considered in your system design. For the first tests the shield plate of the Developer's Starter Kit (EVICO-XV-SHIELD\_THRD) can/should be used as shown in Fig. 6 and Fig. 7.

To set up the VICO-DV 2.0/AV 2.0 correctly please refer to chapter 5.

For ordering part numbers see section 3.1.



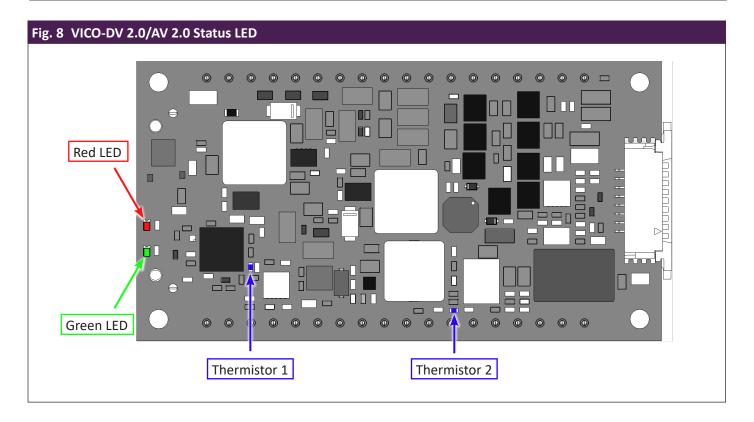




### 4.4 VICO-DV 2.0/AV 2.0 Status LED

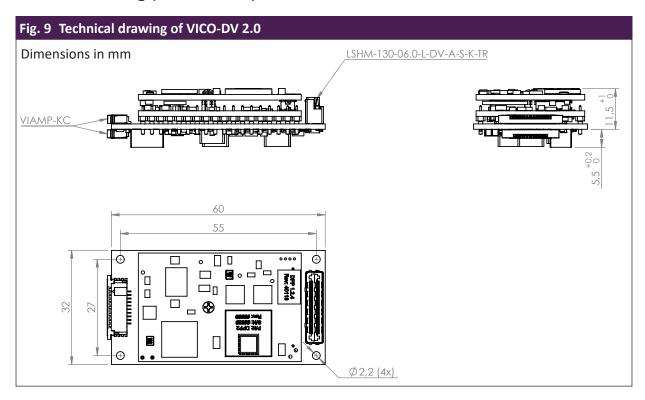
The VICO-DV 2.0/AV 2.0 is equipped with two status LEDs (red and green) shown in Fig. 8 which can be used for diagnostics. The function of those LEDs is described below.

Tab. 9 LED status	
Status	Description
Red LED is on or blinks	On: VICO-DV 2.0/AV 2.0 error state detected
	Blinking: VIAMP error state detected
	Please read out the error status code using the advanced functions described in sections 6.4.2.1 and 6.4.2.2 for more information on the failure.
Green LED is on or blinks	On: chip temperature difference to the desired value equals or is higher than 20 K.
	Blinking: chip temperature difference to the desired value is lower than 20 K but the setpoint has not been reached yet.

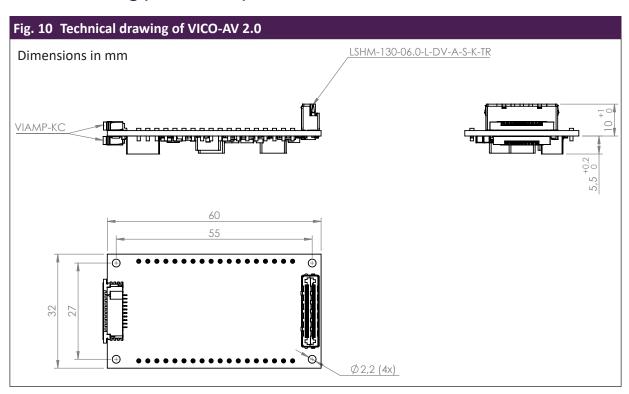




### 4.5 Technical drawing (VICO-DV 2.0)



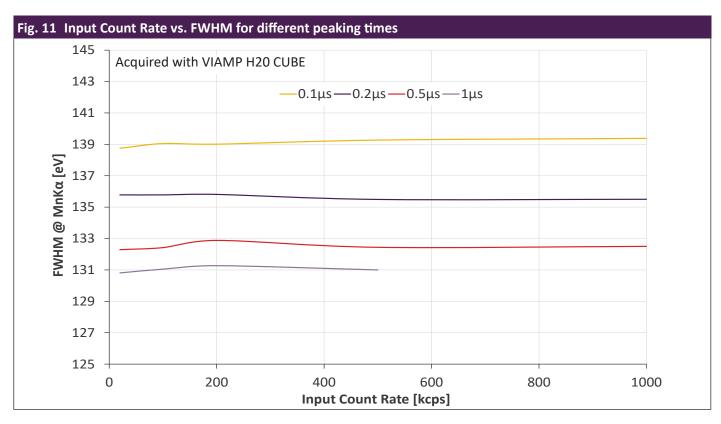
### 4.6 Technical drawing (VICO-AV 2.0)

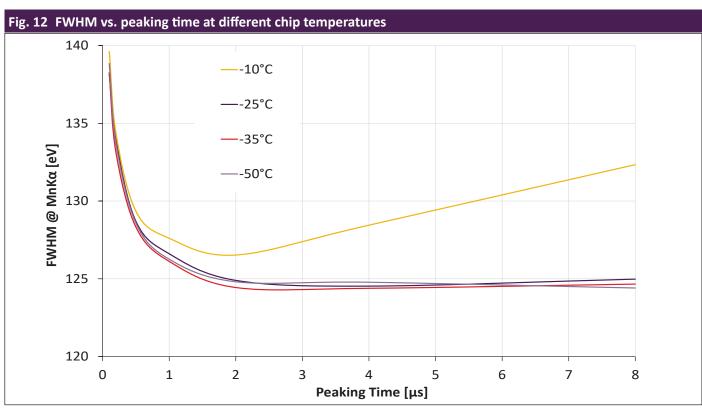




### 4.7 Spectroscopic Performance

The VICO-DV 2.0/AV 2.0's spectroscopic performance is determined by the VIAMP module. Typical performance is shown in the following graphs.







#### 5 Getting started

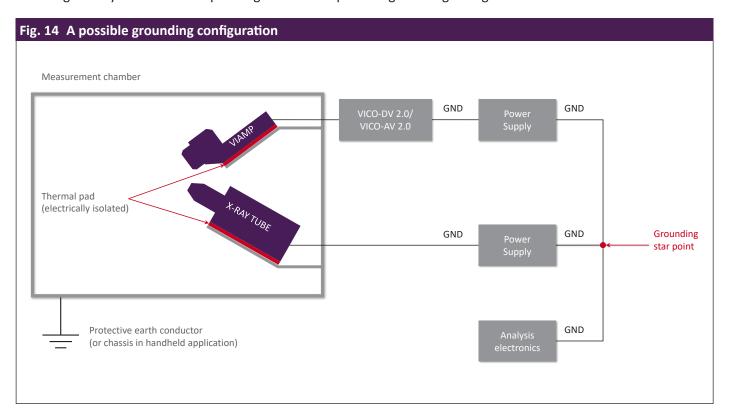
#### **IMPORTANT**

Make sure that all necessary requirements for meeting the ESD cautions are fulfilled.

- Remove the VICO-DV 2.0/AV 2.0 and VIAMP carefully from the transport case.
- 2. Leave the protection cap on the SDD in order to avoid window damage while handling the system (Fig. 13).



- 3. Mount the VICO-DV 2.0/AV 2.0 in your measurement equipment at a desired position, using the four fixation holes. Please note that the holes are electrically connected to ground potential.
  - Proper shielding is necessary to achieve an excellent spectroscopic performance with the VICO-DV 2.0/AV 2.0, thus it should be considered in course of the instrument design. E.g. it is recommended to mount the VICO-DV 2.0/AV 2.0 to a metal plate in the final instrument, as this increases the immunity of the board against potential parasitic electomagnetic interferences.
  - Moreover, make sure that the grounding star point of the system is close to the power supply or in case you are using battery close to the '-' pole. Fig. 14 shows a possible grounding configuration of the instrument.





#### IMPORTANT

Please notice that the devices are not designed to be operated under vacuum conditions.

- 4. Mount the VIAMP in a way that it is electrically isolated but thermally conductive, as the VIAMP housing functions as a heat sink.
- 5. Connect the VIAMP and the VICO-DV 2.0/AV 2.0 with the 8-pole and 10-pole FFC cable. Cable orientation: contacts on the outside.
- 6. To contact the I/O-Connector (LSHM-130-06.0-L-DV-A-S-K-TR) of the VICO-DV 2.0/AV 2.0 a breakout board is strongly recommended. You can use either the EVICO-XV-ADAPTER-S/-L from Starter Kit (s. section 4.3) or your own design (for I/O connector pinning see section 4.1.3).
  - a. using KETEK's Developer's/Starter Kit (for details see section 4.3)
    - i. Connect the EVICO-XV-ADAPTER-S/-L from the Developer's Starter Kit.
    - ii. Plug in the APS-GE24I05-P1J.
    - iii. Be sure that the PWR LED indication is on.
    - iv. Wait until the RDY LED indication lights up. Your VICO-DV 2.0/AV 2.0 & VIAMP system is ready for operation.
    - v. Connect USB, respectively RS232, with the PC (VICO-DV 2.0 only).
    - vi. Connect the SIGNAL connector to an oscilloscope using a BNC cable to check preamplifier output signal.
  - b. using your own breakout board
    - i. Connect your own breakout board. Please refer to section 4.1.3 for details on pinning.
    - ii. Turn on the power supply.
    - iii. Connect analog preamplifier output signal to an oscilloscope to check preamplifier output signal.



#### IMPORTANT

Avoid a mechanical contact with the SDD at any time, as this may cause a SDD window damage which is not covered by warranty.

- 7. Remove the protection cap slowly and carefully. Do not touch the SDD window with your fingers or with the protection cap.
- 8. Place your X-ray signal source in front of the SDD. Be aware of the X-ray radiation and proceed in accordance with Radiation Safety regulations!
- 9. Check preamplifier analog output signal using an oscilloscope. The typical output signal is a ramp as shown in Fig. 15 and Fig. 16 (under X-ray radiation exposure). Every single step on the ramp signal corresponds to a photon which has been absorbed in the SDD. By measuring the height of this step the energy of this photon can be determined.

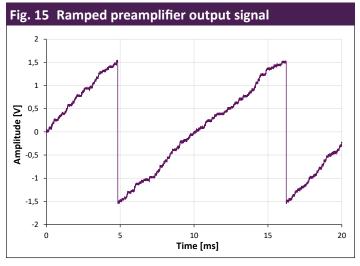
The ramped signal is caused by the leakage current of the SDD, which leads to a continuously rising output signal level. This is a normal behavior which occurs even if the SDD is not exposed to any radiation.

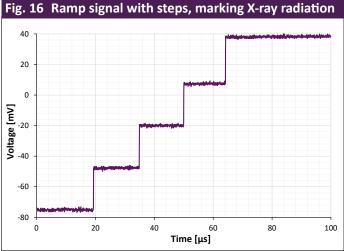
In order to avoid an electrical saturation of the signal-processing electronic, the signal level is periodically reset as soon as a particular signal level has been reached. Thus, the signal cannot exceed a defined voltage range. During



the reset procedure (typically < 500 ns), no valuable information can be acquired and the signal is being lowered to the base level.

10. Please continue reading the VICO-DP manual for details on operating the VICO-DV 2.0 (appendix). See section "3 The ProSpect Software" for more details on the provided ProSpect software.





#### **Analog SDD temperature readout**

The temperature of the SDD chip can be measured by using the integrated temperature readout circuit.

The pin TEMP Output (pin 11, see I/O connector pinning in section 4.1.3) provides positive voltage which should be measured with a high ohmic ( $\geq 1 \text{ M}\Omega$ ) multimeter or ADC input. This output is buffered and in the range of  $\pm 3 \text{ VDC}$ . Typically it is below 1.5 VDC.

The temperature readout circuit consists of a thermistor which is mounted inside the SDD module on the rear side of the its interposer.

The thermistor whose resistance varies with changing temperature is supplied with a constant current. As a consequence the thermistor voltage is correlated to the thermistor temperature.

To determine the SDD temperature it is necessary to measure the TEMP Output voltage (pin 11, section 4.1.3) and to compare the measured value with look-up table below (Tab. 10 on page 18).



**NOTE** 

The chip temperature can be read out and set using the advanced functions described in chapter 6.



b. 10 T	emperature	e readout table	
DD temp. [°C	] TEMP [V]	SDD temp. [°C]	TEMP [V]
-80	2.421	-44	1.618
-79	2.414	-43	1.578
-78	2.406	-42	1.539
-77	2.398	-41	1.499
-76	2.389	-40	1.458
-75	2.380	-39	1.418
-74	2.369	-38	1.377
-73	2.358	-37	1.337
-72	2.347	-36	1.296
-71	2.334	-35	1.256
-70	2.321	-34	1.216
-69	2.307	-33	1.117
-68	2.292	-32	1.137
-67	2.276	-31	1.099
-66	2.259	-30	1.060
-65	2.241	-29	1.023
-64	2.222	-28	0.986
-63	2.201	-27	0.950
-62	2.180	-26	0.914
-61	2.158	-25	0.880
-60	2.135	-24	0.846
-59	2.110	-23	0.813
-58	2.085	-22	0.781
-57	2.058	-21	0.750
-56	2.030	-20	0.720
-55	2.001	-19	0.690
-54	1.971	-18	0.662
-53	1.940	-17	0.635
-52	1.907	-16	0.608
-51	1.874	-15	0.582
-50	1.840	-14	0.558
-49	1.805	-13	0.534
-48	1.769	-12	0.511
-47	1.732	-11	0.489
-46	1.695	-10	0.468
-45	1.656	-9	0.448
-40	1.030	-5	0.740



#### 6 Advanced Functions

#### 6.1 Introduction

The VICO-DV 2.0/AV 2.0 features some advanced functions which can be accessed over USB or RS232 interfaces. Those are:

- Live info data VICO-DV 2.0/AV 2.0: contains current operation parameters of the board
- Live info data VIAMP: contains current operation parameters of the VIAMP
- Device info data VICO-DV 2.0/AV 2.0: contains information on the software and hardware version of the board
- Device info data VIAMP: contains information on the connected VIAMP
- Device state mode setting: sets the device state mode, e.g. ECO mode
- Chip temperature readout: provides the actual chip temperature
- Chip temperature setting: sets the desired chip temperature

As those functions are managed by the integrated VICO-DV 2.0/AV 2.0 microcontroller which must be accessed either over the DPP (VICO-DV 2.0) or directly (VICO-AV 2.0):

- a. VICO-AV 2.0: direct microcontroller access. In this case dedicated pins MCU RXD (pin 38) and MCU TXD (pin 37) of the I/O connector (section 4.1.3) need to be used for the direct microcontroller access. Please be referred to section 6.2 for more details.
- b. VICO-DV 2.0: microcontroller access through the DPP. The DPP command 'passthrough' needs to be used which tunnels the data between the software and the microcontroller. Both USB and RS232 interfaces do support this command (see section 6.3 for more details).



#### IMPORTANT

The advanced functions should not be used during a running data acquisition in order to avoid any interferences.

The data structure (so-called datagrams) which is sent and received is described in section 6.4.

#### 6.2 Direct access to the microcontroller (VICO-AV 2.0)

This method is valid for the analog systems without KETEK DPP. As the analog version of the board is not equipped with the KETEK DPP the microcontroller must be accessed directly over the dedicated pins MCU RXD (pin 38) and MCU TXD (pin 37) of the I/O connector (pinning described in section 4.1.3). The microcontroller enables the communication over the RS232 protocol. Thus the pins MCU RXD and MCU TXD should be connected to a device which supports the RS232 protocol, e.g. a PC. A RS232-to-USB converter can also be used.

The datagrams can be transferred and received to the microcontroller over this RS232 connection. The datagrams are described in section 6.4.



#### 6.3 Microcontroller access over DPP 'Passthrough' command (VICO-DV 2.0)

This method is valid for the digital systems with KETEK DPP. The data (datagrams) are tunneled to and from the microcontroller over the DPP command 'passthrough'. Both USB and RS232 interfaces support this command and are described below.

#### 6.3.1 Over USB (using DLL)



**NOTE** 

In order to use the passthrough function a Handel DLL 1.2.17 or higher is necessary.

The Handel DLL contains a function which can be called with the passthrough parameter xiaBoardOperation(0, "passthrough", value); where value({byte\*, int\*, byte\*, int\*}) and

byte\* send: an array of bytes (datagram) to send with the command

int\* send length: number of bytes in the send array

byte\* receive: an array of bytes (datagram) to return the command response

int\* receive length: number of bytes to read in the command response

Please refer to the example below for more details.

```
byte send[32] = \{1, 2, 3\};
int send len = sizeof(send) / sizeof(send[0]);
byte receive [32] = \{0\}
int receive len = sizeof(receive) / sizeof(receive[0]);
void* value[4] = {send, &send len, receive, &receive len};
int status = xiaBoardOperation(0, "passthrough", value);
CHECK ERROR (status);
/* Process receive... */
```



#### 6.3.2 Over RS232 (direct interface access)

The passthrough command can be also issued in case of the RS232 interface. The general structure for commands and responses is as follows:

[Esc] [Command] [Ndata (2 bytes)] [data1] ... [dataN] [XOR CS]

correct an error response is returned.

#### where:

[Esc] Escape (ASCII 0x1B) as a command start byte Single byte for command number, allowing up to 255 commands. See the tables below for command [Command] definitions. Number of data bytes to follow. Two bytes, low byte first. [Ndata] Exclusive-or checksum (bitwise XOR of all bytes except for the initial [Esc]). If the checksum is not [XOR CS]

The format of responses echo the format of commands; that is, they start with the [Esc] character and pass back the command # to which it is responding, followed by appropriate data and checksum. The first data byte of all responses is the return status, which is zero for a successful command. In case of an error, only the error byte is returned – no other data bytes are sent.



#### **⚠** NOTE

Please note that it is necessary to receive the entire response from one command before sending the next command, as there is no queuing of commands.

The passthrough command is described below in Tab. 11.

Tab. 11 Passthroug	th command structure						
Command	Meaning	Response data					
0xC0: passthrough	_	Ndata = 1 or 34					
	microcontroller. Number of bytes sent and received is fixed at 32 (length of the data-	[data1] = Command status					
	grams); this command just passes the data	0:OK; 1: Command failure					
	back and forth – there is no interpretation or verification of the command data.	On failure, only one byte is returned.					
		For a successful command, the following byte					
	Ndata = 32	are sent:					
	[data1 32] = Command bytes to send	[data2] = Passthrough status					
	senu	0: OK					
		1: Timeout					
		2: Incomplete response					
		[data3 data34] = Returned command bytes (missing bytes set to FF)					



#### 6.4 Datagrams

#### 6.4.1 General datagram structure

Each datagram consists of exact 32 bytes. This applies for request and response datagrams.

#### 6.4.1.1 Request datagram (ReqD) structure

The request datagram begins always with the advanced function number (CIX) to be sent to the microcontroller (see section 6.4.2 for more details on available advanced functions), followed by 29 bytes of data. The content of that data depends on the advanced function. The last two bytes contain the required CRC checksum.



The CRC checksum should be calculated according to the CRC-16/CCITT-FALSE standard.

An example for CRC checksum calculation in C language is shown below:

```
static uint16 t gen crc16(char* pData, int length) {
  uint8 t i;
  uint16 t wCrc = 0xffff;
  while (length--) {
     wCrc ^= *(unsigned char*)pData++ << 8;</pre>
     for (i = 0; i < 8; i++)
           wCrc = wCrc & 0x8000 ? (wCrc << 1) ^ 0x1021 : wCrc << 1;
  return wCrc & 0xffff;
```

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	CIX															
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CF	RC

#### 6.4.1.2 Response datagram (ResD) structure

After the request datagram has been sent the VICO-DV 2.0/AV 2.0 responds always with the response diagram. Due to the synchronous communication the response corresponds to the last request datagram. In the meantime no additional datagram will be processed. The first byte contains the advanced function number the datagram responds to. The second byte carries the response status code (RC). The next 28 bytes can be used for the data to be transferred. CRC sum is located at bytes 30 and 31.

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	CIX	RC														
Duta	1.0	47	40	10	20	24	22	22	24	25	26	27	20	20	20	24
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CRC	

The list of the response status codes (RC) is shown in Tab. 12 (command referrers to an advance function).



Tab. 12 List of	of possible response status codes (RC)
Value (hex)	Description
01	Command not supported
02	Wrong CRC checksum
10	Error (something went wrong during the command processing)
20-5f	Defined command error (if supported by the issued command)
FF	Successful

#### 6.4.2 Available advanced functions

The advanced functions listed in Tab. 13 can be used by issuing a datagram with the corresponding function number and proper data.

Tab. 13 Avail	able advanced functions
Function no.	Description
0x10	Live info data VICO-DV 2.0/AV 2.0: contains current operation parameters of the board
0x11	Live info data VIAMP: contains current operation parameters of the VIAMP
0x15	<b>Device info data VICO-DV 2.0/AV 2.0</b> : contains information on the software and hardware version of the board
0x16	Device info data VIAMP: contains information on the connected VIAMP
0x20	Device operation mode setting: sets the device operation mode, e.g. ECO mode
0x30	Chip temperature readout: provides the actual chip temperature
0x31	Chip temperature setting: sets the desired chip temperature

#### 6.4.2.1 0x10 Live info data VICO-DV 2.0/AV 2.0

#### 6.4.2.1.1 0x10 Request datagram (ReqD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x10															
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CF	RC

#### 6.4.2.1.2 0x10 Response datagram (ResD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x10	RC	ST	ER		V_	IN		РО				THERM_1			
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content	THERM_2														CF	RC

#### where

- ST (state): current state of the VICO-DV 2.0/AV 2.0 (see section 6.5.1 for more details)
- ER (error): current error code of the VICO-DV 2.0/AV 2.0 (see section 6.5.1 for more details)
- V\_IN: current input voltage in [V] (32 bit float)



- PWR\_OUT: current power output state (bool)
- THERM\_1: temperature of the thermistor #1 in [°C] (32 bit float)
- THERM\_2: temperature of the thermistor #2 in [°C] (32 bit float)

#### 6.4.2.2 0x11 Live info data VIAMP

#### 6.4.2.2.1 0x11 Request datagram (ReqD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x11															
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CF	RC

#### 6.4.2.2.2 0x11 Response datagram (ResD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x11	RC	ST	ER		CURI	RENT			VOL	TAGE			SDD_	TEMP	
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content	RDY					HOT_	SIDE								CF	RC

#### where

- ST (state): current state of the VIAMP (see section 6.5.2 for more details)
- ER (error): current error code of the VIAMP (see section 6.5.2 for more details)
- CURRENT: Peltier SDD cooler current in [A] (32 bit float)
- VOLTAGE: Peltier SDD cooler voltage in [V] (32 bit float)
- SDD\_TEMP: SDD temperature readout in [°C] (32 bit float)
- RDY: current state of the 'Ready' indication(bool)
- HOT\_SIDE: heat sink temperature readout in [°C] (32 bit float)

#### 6.4.2.3 0x15 Device info data VICO-DV 2.0/AV 2.0

#### 6.4.2.3.1 0x15 Request datagram (ReqD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x15															
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CF	RC

#### 6.4.2.3.2 0x15 Response datagram (ResD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x15	RC	SMJ	SMI	SMS					PCB_S	SERIAL	[0-10]				
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content		16   17   18   19   20   21   22   23   24   25   26   27   28   29   29   20   21   20   21   20   21   20   21   20   21   22   23   24   25   26   27   28   29   20   21   20   21   22   23   24   25   26   27   28   29   20   21   20   20													CF	RC



#### where

- SMJ (software major) contains the software-major version number
- SMI (software minor) contains the software-minor version number
- SMS (software sub) contains the software-sub version number
- PCB\_SERIAL: contains the PCB serial number of the VICO-DV 2.0/AV 2.0
- SMB (software build) contains the software-build version number (Big Endian: most significant byte first)

#### 6.4.2.4 0x16 Device info data VIAMP

#### 6.4.2.4.1 0x16 Request datagram (ReqD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x16															
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CF	RC

#### 6.4.2.4.2 0x16 Response datagram (ResD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x16	RC						PC	B_SERI	AL [0-1	L3]					
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content			DCB S	EDIAI [	[14-20]			7	A D C E T	TEMI	)				CF	3C

#### where

- PCB\_SERIAL contains the PCB serial number of the VIAMP
- TARGET\_TEMP contains the target SDD chip temperature stored in EEPROM memory in [°C] (32 bit float)

#### 6.4.2.5 0x20 Device operation mode setting

#### 6.4.2.5.1 0x20 Request datagram (ReqD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x20	MD														
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CF	RC

#### 6.4.2.5.2 0x20 Response datagram (ResD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x20	RC														
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CF	RC

#### where

• MD (mode) contains the requested operation mode of the system (see section 6.5.3 for available modes)



#### 6.4.2.6 0x30 Chip temperature readout

#### 6.4.2.6.1 0x30 Request datagram (ReqD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x30															
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CI	20

#### 6.4.2.6.2 0x30 Response datagram (ResD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x30	RC		TTEM	_CUR			TTEM	P_DEF		RDY					
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CF	RC

#### where

- TTEMP\_CUR (temperature current): current chip temperature in [°C] (32 bit float)
- TTEMP\_DEF (target temperature): target chip temperature in [°C] (32 bit float)
- RDY: current state of the 'READY' indication(bool)

#### 6.4.2.7 0x31 Chip temperature setting

#### 6.4.2.7.1 0x31 Request datagram (ReqD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x31		TTE	MP												
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CF	RC

#### 6.4.2.7.2 0x31 Response datagram (ResD)

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	0x31	RC														
Byte	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Content															CF	RC

#### where

• TTEMP (target temperature): target chip temperature in [°C] (32 bit float)



The set chip temperature will be restored to the default value after a power cycle. This default value is preset in the VIAMP memory and cannot be changed by the user.



## **6.5** Device operation states and errors

### 6.5.1 VICO-DV 2.0/AV 2.0

Tab. 14 VICO	-DV 2.0/AV 2.0 operation states
Value (hex)	Description
00	Initialization
01	Operation
02	Error (see error codes in Tab. 15)
03	ECO3

Tab. 15 VICC	Tab. 15 VICO-DV 2.0/AV 2.0 error codes			
Value (hex)	Description			
00	Unknown error			
01	+5 V voltage out of range (+5V_ANA and +5V_DIG)			
02	Microcontroller voltage out of range (+3V3_MCU)			
03	+2.5 V voltage out of range (+2V5_REF)			
04	Thermistor #1 temperature out of range (upper limit)			
05	Thermistor #2 temperature out of range (upper limit)			
06	Input voltage out of range ( $V_{IN}$ )			
07	no error			

### 6.5.2 VIAMP

Tab. 16 VIAM	1P operation states
Value (hex)	Description
00	Inactive
01	Enabling -5 V voltage
02	Recognizing SDD thermistor
03	Testing I2C connection
04	VIAMP not connected or connection failed
05	Checking the EEPROM CRC checksum
06	EEPROM CRC checksum not valid or invalid VIAMP thermistor mode (linearization not supported)
07	Enabling high voltage
08	Error (see error codes in Tab. 17)
09	Initializing Peltier and checking the ring voltages
Α	VIAMP ready for operation
В	ECO1 operation mode active
С	FULL operation mode active
D	High voltage disabled
Е	ECO2 operation mode active



Tab. 17 VIAMP error codes		
Value (hex)	Description	
00	Unknown	
01	No connection to VIAMP over thermistor	
02	No connection to VIAMP over I2C	
03	EEPROM CRC checksum not valid	
04	Thermistor is set to linearization (not supported)	
05	Unstable high voltage	
06	SDD ring voltages invalid	
07	no error	

### 6.5.3 Available device operation modes

Tab. 18 List of available device operation modes			
Value (hex)	Description		
00	No request		
01	FULL		
02	Power saving ECO1: SDD chip temperature set to 0 °C (same as setting the chip temp. manually)		
03	Power saving ECO2: Peltier off		
04	Power saving ECO3: VIAMP -5 V off, high voltage off, Peltier off (maximum power saving but the longest recovery time to FULL operation mode)		



### 7 Troubleshooting

This VICO-DV 2.0/AV 2.0 unit has passed the quality control and the functional test. Thus; no technical malfunction is expected during the operation. However; if you are experiencing an unusual behavior of the system please read the instructions below. In case the existing problem is not listed or the proposed actions did not solve the issue please contact the KETEK support team.

Tab. 19 Troubleshooting					
Issue	Possible solution				
Red LED is on or blinks	On: VICO-DV 2.0/AV 2.0 error state detected				
(on VICO-DV 2.0/AV 2.0 board)	Blinking: VIAMP error state detected				
	Please read out the error status code using the advanced functions described in sections 6.4.2.1 and 6.4.2.2 for more information on the failure.				
Green LED is on or blinks (on VICO-DV 2.0/AV 2.0 board)	On: chip temperature difference to the desired value equals or is higher than 20 K.				
	Blinking: chip temperature difference to the desired value is lower than 20 K but it has not been reached yet.				
PWR LED remains off (KETEK breakout board)	The power supply of the VICO-DV 2.0/AV 2.0 is not working properly or has not been properly connected to the board:				
	<ul> <li>Check the red LED placed on the VICO-DV 2.0/AV 2.0 board. In case it is on or blinks a hardware error state has been detected. Thus readout the errors status codes described in sections 6.4.2.1 and 6.4.2.2.</li> </ul>				
	<ul> <li>Check the power supply whether it provides the necessary voltage</li> </ul>				
	<ul> <li>Verify the connection between VIN/GND pins of the I/O connector and the power supply</li> </ul>				
RDY LED remains off	The set SDD temperature has not been reached:				
(KETEK breakout board)	Please wait at least 1-2 min. after powering up the device.				
	• The SDD temperature has been set to a too low value which the cooler cannot reach. Set the SDD to a higher temperature.				
	• The ambient temperature is too high and the desired SDD temperature cannot be reached. Set the SDD to a higher temperature.				
	<ul> <li>The thermal coupling between the VIAMP and the instrument is not sufficient. Please be sure that the heat generated by the VIAMP can dissipate properly.</li> </ul>				
The VICO-DV 2.0 is not recognized	The VICO-DP driver is not installed properly:				
by Windows as KETEK DPP2	<ul> <li>Please refer to the VICO-DP Manual and proceed with the software installation described in chapter 3 (appendix).</li> </ul>				



Tab. 19 Troubleshooting	
Poor spectroscopic performance	KETEK specifies the full width at half maximum for Mn-K $\alpha$ peak with 55Fe as an X-ray source.
	• The FWHM performance is directly related to the detector temperature. Thus, be sure the specified SDD temperature has been reached.
	<ul> <li>The other electrical devices near the detector, e.g. the X-ray tube, can induce a noise in the spectrum. Be sure that other devices are electrically decoupled from the VIAMP.</li> <li>The VIAMP housing should be electrically decoupled from the instrument.</li> </ul>
	<ul> <li>Be sure that your grounding and shielding concept do not induce a noise into the system (e.g. grounding loops). Refer to Fig. 13 on page 15.</li> </ul>
Noise (zero) peak visible in spectrum	Most likely there is an electrical component (e.g. X-ray tube power supply) in your setup causing an extensive noise which is visible in the spectra as a zero peak:
	• Turn off the electrical components one-by-one and monitor the zero peak in the spectrum in order to identify the noisy one.
	<ul> <li>Improve the shielding between the VIAMP/VICO board and the noisy component.</li> </ul>
	<ul> <li>Verify your grounding concept.</li> </ul>
	<ul> <li>Adjust the DPP trigger value (in case of the VICO-DV 2.0 please refer to the VICO-DP Manual, section 3.7.1 in appendix).</li> </ul>



### **8 EMC Declaration of Conformity**

Test Report: 292201802A



# **Test Report**

**Electromagnetic Compatibility** 

Test report: 292201802A

Test Item	
Description	OEM electronic systems for combination with VIAMP module
Туре	VICO-DV 2.0

Contracting Partner			
Client (name / address)	KETEK GmbH Hofer Str. 3 81737 Munich		
Order number	98292		
Test laboratory (name / address)	J. Schmitz GmbH EMV-Kompetenzzentrum Chiemseestraße 21 83022 Rosenheim / Germany		

Test		
Test Standard (specification)	EN 61326-1:2013	
Time Range of the Test	12.12.2018	
Result (details on page 7-8)	<ul> <li>☐ Requirements met</li> <li>☐ Requirements not met</li> <li>The result of the test exclusively concerns the above-mentioned test item.</li> </ul>	
Date of issue	06.02.2019	
Test conducted by	Josef Arnold Responsible tester Signature	
Authorised by	Thomas Mauck Laboratory manager EMC  Laboratory manager EMC  Laboratory manager EMC  Signolative No. 21, 83022 ROSENI  Total (08031) 13255	

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abstract of Test Report: 292201802A



#### Overview of tests performed

The measurement and test results are documented in the following test protocols. Table 1 and 2 summarise all test results.

Table 1 – Results of the immunity tests

	N 61326-1:2013							
Table/	Test level		Test result				Test protocol	Comments
section			Р	F	NA	NP		
	tatic discharge ndard: EN 61000-4-2							
1.5	Enclosure: contact	± 4 kV					Appendix A	
1.5	Enclosure: air	± 8 kV	$\boxtimes$					
	equency electromagne ndard: EN 61000-4-3	tic field						
1.2	Enclosure: 80 MHz - 1.0	GHz 10 V/m					Appendix B	
1.3	Enclosure: 1.4 GHz - 2.0	GHz 3 V/m	$\boxtimes$					
1.4	Enclosure: 2.0 GHz - 2.7	GHz 1 V/m	$\boxtimes$					
Fast trai	nsients ndard: EN 61000-4-4							
2.2	Signal port:	± 1.0 kV			$\boxtimes$		Appendix C	Comment 1
3.3	DC port:	± 2.0 kV			$\boxtimes$			
4.5	AC port:	± 2.0 kV			$\boxtimes$			
Surges Basic star	ndard: EN 61000-4-5							
2.3	Signal port:	± 1.0 kV *					Appendix D	
3.2	DC port:	± 2.0 kV * ± 1.0 kV **						
4.4	AC port:	± 2.0 kV * ± 1.0 kV **						
	* asymmetrical (cable agai ** symmetrical (cable agai							
		nst cable)						
	** symmetrical (cable agai	nst cable)					Appendix E	Comment 2
Basic sta	** symmetrical (cable agai equency common mod ndard: EN 61000-4-6 Signal port:	nst cable)					Appendix E	Comment 2
Basic star 2.1	** symmetrical (cable agai equency common mod ndard: EN 61000-4-6 Signal port: 0.15 MHz – 80 MHz DC port:	nst cable)					Appendix E	Comment 2
2.1 3.1 4.1  Power-f	** symmetrical (cable agai equency common mod ndard: EN 61000-4-6 Signal port: 0.15 MHz – 80 MHz DC port: 0.15 MHz – 80 MHz AC port:	st cable)			$\boxtimes$		Appendix E	Comment 2

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abstract of Test Report: 292201802A



Norm: EN 61326-1:2013								
Table/	Test level		Test result				Test protocol	Comments
section			Р	F	NA	NP		
Voltage dips and interruptions Basic standard: EN 61000-4-11								
4.2	$\begin{tabular}{lll} AC port: & & & & & & \\ 0 \% \ U_N & & & 1 \ cycle \\ 70 \% \ U_N & & 25 \ cycles \\ 40 \% \ U_N & & 10 \ cycles \\ \end{tabular}$				$\boxtimes$		Appendix G	
4.3	AC port: 0 % U <sub>N</sub> 250 cycles							
Comment 1: The DC supply input has to be protected against bursts by the user.  Comment 2: The DC supply of DUT was tested as IO-Port; resp. EN 61326-1, table 2 note f								

# Table 2 –Results of emission tests

Norm: E	N 61326-1:2013						
Table/	Test content	Test result				Test protocol	Comments
Table/ section		Р	F	NA	NP		
Conducted emissions Test norm: EN 55011, Class A							
2	AC port: 0.15 MHz – 30 MHz			$\boxtimes$		Appendix H	
3	DC port: 0.15 MHz – 30 MHz			$\boxtimes$			
4	Telecommunication/power port: 0.15 MHz – 30 MHz			$\boxtimes$			
Radiated emissions Test norm: EN 55011, Class A							
1.2	Enclosure: 30 MHz – 1 000 MHz	$\boxtimes$				Appendix J	Comment 1
1.4	Enclosure: 1 000 MHz – 5 000 MHz			$\boxtimes$			
Harmonic current emissions							
Test norm	n: EN 61000-3-2, device of class A, table 1						
2	Input current Class A					Appendix J	Comment 2
Voltage changes, voltage fluctuations and flicker Test norm: EN 61000-3-3, section 5							
2	AC port			$\boxtimes$		Appendix J	Comment 3
Comment	Comment 1: alternative measuring station, FAR hall						
Comment 2: no limits established for rated power <75 W (from EN 61000-3-2:2006 + A1:2009 + A2:2009, section 7)							
Comment 3: device and facility, that won't have with a certainly probability significant voltage fluctuations and flicker, don't							
have to b	e tested (from EN 61000-3-3:2008, section 6.	1).					

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# 9 Contact

If you have any questions regarding this or any of our products please do not hesitate to contact us via e-mail or phone.

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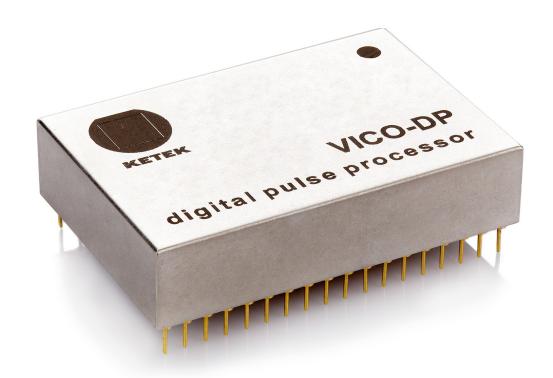
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# **Digital Pulse Processor**

Manual







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# **Revision history:**

Rev. 1.3, June 2020: Minor changes

Rev. 1.2, December 2017: Adapted to the ProSpect 1.1.14 Rev. 1.1, July 2017: Multichannel section 2.1.3 added

Rev. 1.0, June 2016



Dear Customer,

Thank you for choosing the KETEK VICO-DP. We ensure you that this product has been manufactured with highest industry standards in order to meet your quality expectations. Our highest priority is to deliver you the best product on the market.

The purpose of this start-up guide is to provide new KETEK VICO-DP users with an easy-to-use reference for getting to work with the ProSpect software application.

# 1 Safety instructions



**NOTE** 

It is strongly recommended to keep to the instructions in this manual when installing the VICO-DP.

Please keep this user manual always with the system to allow any operator access to this important information.

The safety instructions are provided both for your protection and to prevent damage to the VICO-DP and connected equipment. This safety information applies to all operators and service personnel.

# 2 Product Description

The high-performance Digital Pulse Processor VICO-DP is a high-rate, digitally-based, multi-channel analyzer (MCA), designed for energy-dispersive X-ray measurements in benchtop, portable and embedded systems.

Its analog front-end is optimized for KETEKs preamplifiers. The VICO-DP offers computer control over all available amplifier and spectrometer parameters including gain, filter peaking time, and pileup inspection criteria. VICO-DP firmware and parameters are stored locally in non-volatile memory.

The VICO-DP features extremely short peaking times down to 100 ns and is optimized for KETEKs ASIC-based SDD modules.

The VICO-DP is available as a plugin module for KETEKS AXAS-A, AXAS-M and VICO-AV.



## 2.1 Features

# 2.1.1 General Spectrometer Features

- Dimensions: 46.55 x 31.3 x 11 mm<sup>3</sup>.
- Operates with all KETEK AXAS and VICO-DV.
- The VICO-DP requires several DC voltage supplies for operation. The VICO DP's power consumption is less than 1 Watt
- Multi-channel analysis with up to 8K (8192) bins allows for optimal use of data to separate fluorescence signal from backgrounds.
- Instantaneous throughput beyond 1,000,000 counts per second (cps).
- Digital trapezoidal filtering, with programmable peaking times between 100 ns and 24 µs in 24 steps.
- Digitally-controlled analog gain: 6 dB range, 2 discrete settings.
- Digital fine gain trim: 16-bit precision.
- Pileup inspection criteria computer settable, including fast channel peaking time, threshold, and rejection criterion.
- Accurate ICR and live-time reporting for precise dead-time corrections.

# 2.1.2 Embedded Systems Features

- Data acquisition and control via USB 2.0 high-speed or RS-232.
- Twenty-four (24) sets of optimized spectrometer parameters, or PARSETs, are stored and retrieved on a per-peaking-time basis in nonvolative memory.
- Five (5) sets of MCA parameters, or GENSETs, are stored and retrieved in nonvolative memory.
- The provided ProSpect software application for VICO-DP parameter set configuration—intended for use both in evaluation and production phases.
- DLL. The combination of ProSpect+DLL only works with Windows. The source code package for Windows or Unix is available on request.

# 2.1.3 Multichannel Operation

Several systems equipped with VICO-DPs can be connected to the same host PC and operated simultaneously.



**NOTE** 

Multichannel operation is only possible in case of the systems with the same VICO-DP firmware version. Otherwise a reliable operation cannot be guaranteed. This could be the case if the systems have been purchased separately. Please contact KETEK for more details.

# 2.2 Hardware Requirements

# **HOST COMPUTER**

The VICO-DP can communicate with any host computer/controller via USB or RS-232.



**NOTE** 

The ProSpect software is only available for Windows operating systems!



### **DETECTOR / PREAMPLIFIER**

The VICO-DP accommodates all KETEK detector preamplifier signals. The voltage compliance range in the analog circuitry imposes the following constraints.

Tab. 1 Analog input signal constraints for pulsed-reset preamplifiers					
Parameter	Minimum	Maximum	Typical		
X-ray pulse-height	1.5 mV	400 mV	30 mV		
Input voltage range	-	+/-4 V	+/-2 V		

# 2.3 Hardware Options

### 2.3.1 Communications

The VICO-DP supports USB2.0 high speed and RS-232 at 921 kbaud. KETEK recommends using the MAX3224E/MAX3245E module or similar for maximum RS-232 communication speed.

### 2.3.2 Analog Input

The analog input signal enters the VICO-DP directly from the preamplifier. For some KETEK systems (AXAS-D and VICO-DV) the analog preamplifier signal is also connected to an external connector for control of this signal.

#### 2.3.3 Gain and Calibration

The variable gain option provides 6 dB of digitally-controlled analog gain in two discrete steps in addition to the digital gain. This allows the VICO-DP to be optimized for a wide range of X-ray energies.

## 2.4 Software Overview

Up to three layers of software may be employed in a VICO-DP instrumentation system:

- A user interface layer (ProSpect)
- A driver layer that communicates between the user interface and the hardware (DLL)
- A firmware layer

# 2.4.1 User Interface, e.g. ProSpect

ProSpect is offered as a general-purpose configuration and data acquisition application.

For instructions on using the ProSpect GUI with the VICO-DP, please refer to §3.

# 2.4.2 Device Drivers, e.g. Handel (DLL)

KETEK provides source code for the high-level spectrometer driver layer that operates with the VICO-DP.

The Handel interface works with basic units (eV, microseconds, etc...) while still allowing for safe, direct-access to the VICO-DP. Please contact KETEK for further information.



#### 2.4.3 Firmware

The VICO-DP operates with a relatively simple command set, accommodating easy implementation into embedded systems. The firmware is not intended to be updated by the user.

# 3 The ProSpect Software

ProSpect is the User Interface for configuring the VICO-DP settings, for performing diagnostic tasks, and for acquiring and exporting spectra.

ProSpect works with Windows 7 and higher. The latest software update can be downloaded from the the KETEK web-

# 3.1 Installation

- 1. Close all applications that are currently running.
- 2. Double-click the installation executable.
- 3. Follow the instructions to install ProSpect and Handel.

When the ProSpect installation is finished, a shortcut to the application will be located on your desktop. A copy of Adobe Acrobat Reader® is required to view the help files distributed with ProSpect. If you need to install Adobe Acrobat Reader®, please do so from the Adobe website:

https://acrobat.adobe.com/us/en/products/pdf-reader.html

#### **FILE LOCATION**

The default location of the ProSpect executable after installation is C:\Program Files (x86)\XIA\ProSpect 1.x

# 3.2 Starting ProSpect for the First Time

ProSpect must first determine to which USB or COM (RS-232 serial) port the VICO-DP is connected, and store that information in a configuration (INI) file.

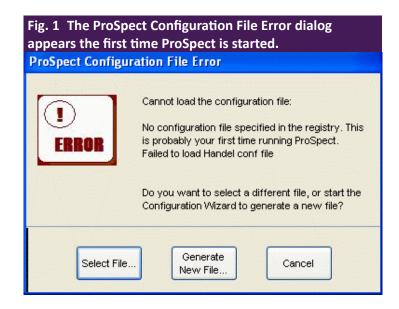
The VICO-DP boots itself upon power-up, and is shortly (about 5 s) thereafter ready to acquire data with the same set of operating parameters used in the previous run. The first time the VICO-DP is powered on, detector- and preamplifier-related parameters will be in the factory default state.



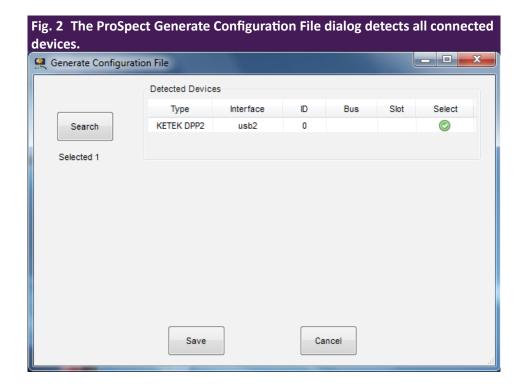
**⚠** NOTE

The VICO-DP requires approximately 5 seconds to boot up, during which time the device can be recognized but cannot be initialized by the host.



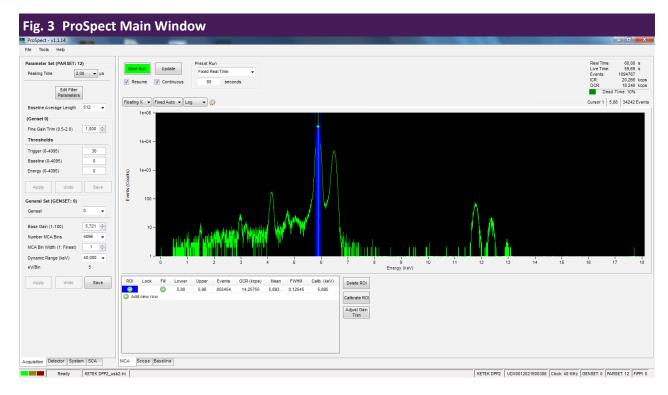


The settings should be optimized and saved to the non-volatile on-board memory so that they will automatically load during subsequent boot operations. The first time ProSpect is started, an error dialog will appear, indicating that no INI file was specified. See Fig. 1.



- 1. Click the [Generate New File...] button to open the **Generate Configuration File** dialog, which displays all detected devices.
- 2. Click in the Select column next to the detected VICO-DP.
- 3. Click the [Save] button to generate an appropriate INI file and proceed with initialization





# 3.3 A Tour Through the Basic ProSpect Features

The Main Window is divided into two panels: The Settings Panel on the left and the larger Main Panel on the right. Both panels are tabbed. In Fig. 3, the **Acquisition** and the **MCA** table are selected.

# 3.3.1 The Settings Panel

The Settings panel contains four tabs:

- Acquisition
- System
- SCA
- Detector

In this guide, we will limit the scope to the **Acquisition** and **Detector** tabs.

In the uppermost section, the **Acquisition** tab provides access to **Peaking Time** selection.

The two sections below contain peaking-time-related PARSET settings and the MCA-related GENSET settings parameters.

The **Settings** panel is intended to be the primary interface for setup and optimization as well as data acquisition, and is referenced throughout the following paragraphs. The Detector tab contains global (GLOBSET) settings related to the detector type and preamplifier characteristics, as described in §3.4.



#### 3.3.2 The Main Panel

The Main panel contains three tabs:

- the MCA spectrum display tab
- the Scope tab
- the Baseline tab

The MCA tab is the default tab, while the Scope and Baseline tabs are for diagnostics

The MCA tab displays the acquired energy spectrum in the plot area and run statistics, e.g. input count rate, real time, etc., in the Statistics area at the top. Statistics for-user specified spectral regions of interest (e.g. ROI-selected peak mean and FWHM) are displayed in the ROI Controls area at the bottom.

The **Scope** tab is an oscilloscope tool for viewing digital signal vectors.

The **Baseline** tab displays the diagnostic baseline histogram and baseline history data. Zooming and panning in all three **Main** panel tabs can be customized by using the **Display Controls** in conjunction with mouse operations both on the axes and in the plot area.

The **Status Bar** along the bottom contains information about the state of the hardware and software, and the hardware serial number. The status indicator at the lower left corner of the main window changes to yellow during RS-232 or USB communications, green when idle and red when an error has been detected.

### 3.3.3 Preview of the Setup Process

The VICO-DP has been designed for ease-of-use in embedded applications. ProSpect can be used to first optimize detector and preamplifier settings and all the parameters associated with each of the 24 **Peaking Times** in combination with up to 5 MCA spectrum formats and then save them to non-volatile memory.

Once setup is complete, the client software application only needs to switch between PARSETs to select the desired **Peaking Time** and MCA spectrum format to retrieve all the optimized settings from non-volatile memory.

The setup process comprises three steps:

- 1. Configuring the detector preamplifier settings,
- 2. Adjusting the MCA format,
- 3. Optimizing the parameters linked to each **Peaking Time**.

# 3.3.4 Parameter Settings: GLOBSET, PARSETs, and GENSETs

Three different types of parameter tables are stored in non-volatile memory: GLOBSET, PARSET, and GENSET.

### **GLOBSET**

The singular GLOBSET is accessible in the **Detector** tab. It contains global settings including detector/preamplifier settings and preset run controls. There is only one GLOBSET. These global settings are used for all peaking times and MCA formats. Changes to these settings are simultaneously applied and saved to nonvolatile memory via the [Apply / Save] button.



#### **PARSET**

The PARSET table is accessible in the top half of the **Acquisition** tab. It includes all peaking-time-dependent settings, e.g. thresholds, sampling interval, etc.

Selecting a new Peaking Time automatically loads a unique set of parameters stored for that peaking time.

There is a complete PARSET table stored in non-volatile memory for each Peaking Time. To maintain energy calibration and proper triggering across every combination of PARSET and GENSET, each PARSET in fact includes **Fine Gain Trim** values and five sets of thresholds; one for each GENSET.

#### **GENSET**

The GENSET table is accessible in the bottom half of the **Acquisition** tab. It defines the number of bins and granularity of the MCA spectrum, as well as the **Base Gain**. Five GENSET tables can be stored, allowing for five different optimized MCA formats. Typically though, only the first GENSET, i.e. GENSETO, is used.

# 3.4 Detector/Preamplifier (GLOBSET) Settings

The global parameter set, or GLOBSET, includes detector type and preamplifier characteristics, accessible in the **Detector** tab of the **Settings** panel (see Fig. 5). ProSpect automatically determines the preamplifier type based upon the firmware installed in non-volatile memory.

The detector settings always include the signal **Polarity**. For reset-type preamplifiers, the **Reset Interval**, the period of time following the preamplifier reset during which data acquisition is disabled, is also included.

# 3.4.1 Viewing the Preamplifier Signal

- 1. Select the **Scope** tab in the Main Panel, which acquires and displays the digital signal vectors from the VICO-DP. See Fig. 4.
- 2. Select ADC from the Trace Type drop-down list.
- 3. Click the [Get Trace] button to refresh the display.



Fig. 4 Scope tool, displaying a series of two X-ray pulses from a reset-type preamplifier. Note that pulses have falling edges, indicating that the polarity setting is wrong.

Options

Trace Type ADC

Sampling interval 0.1 AB

Auto X Auto Y Linear A

1160

1140

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The **Sampling Interval** field controls the time interval between individual points, thus larger values will result in a longer displayed period. The minimum value of 25 ns (for 40 MSPS ADC) results in a displayed period of approximately 200  $\mu$ s. A detailed discussion of the **Scope** tool diagnostics can be found in §3.8.3.

700

300

# 3.4.2 Setting the Polarity

We recommend that you review §3.8.3 for an introduction to the **Scope** tool. The DDP2's digital filters expect positive X-ray pulse-steps, i.e. with a rising edge.

If the displayed X-ray steps have a falling edge, as in Fig. 4, the detector **Polarity** setting must be modified. If the displayed X-ray steps have a rising edge (as in Fig. 5), the VICO-DP polarity setting is correct—proceed to the next section.

To change the **Polarity** setting:

- 1. Select (+) **Positive** or (-) **Negative** from the drop-down list.
- 2. Click the [Apply/Save] button to apply the new setting.
- 3. Store it to non-volatile memory.
- 4. Click the [Get Trace] button again to verify positive pulse-steps.

100

#### 3.4.3 Setting the Reset Interval (Reset-Type Preamplifiers)

Reset preamplifiers produce a large corrective reset step when the large-signal 'staircase' waveform reaches its limit. This reset transient varies for different preamplifiers, both in the duration and in other signal characteristics, e.g. rise time, charge-injection, overshoot and settling time.

Data acquisition should be disabled during the transient. If it is not, artifact events can be introduced into the spectrum and resolution can be degraded due to corruption of the baseline measurement. The **Reset Interval** sets the duration after a preamplifier reset is detected during which baseline and event acquisition is disabled.



The default Reset Interval of 5 µs should work reasonably well for KETEKs SDDs. In any case, the setting is best optimized after gain and threshold settings have been chosen, which affect baseline acquisition. Preamplifier reset transients, and how to properly set the Reset Interval, are discussed in §3.8.3.3.

# 3.5 MCA (GENSET) Settings

The general parameter set, or GENSET, includes the Base Gain and the Number MCA Bins, MCA Bin Width, and other settings that define the MCA spectrum. Up to five complete GENSETs can be modified and stored such that five optimized MCA formats can automatically be retrieved simply by selecting the GENSET parameter.

Here, we simply want to prepare GENSETO with some basic settings.

#### 3.5.1 Gain Overview

We can express the MCA Bin corresponding to an X-ray with voltage amplitude  $\Delta V_{_{Preamp}}$  in terms of ProSpect settings and hardware settings, as:

$$eV / Bin = \frac{Dynamic Range \cdot MCA Bin Width}{8000}$$

A separate bin width setting defines the granularity, and thus the file size, of the MCA energy spectrum.

The change in gain architecture is transparent at the ProSpect application level, i.e. the Handel driver determines the hardware revision and variant, and automatically adjusts the analog and digital gain according to the original acquisition values: Base Gain and Fine Gain Trim. As before, the bin size (eV/Bin) of the MCA spectrum is determined by the MCA Bin Width and Dynamic Range settings.



### **NOTE**

Please note that since ProSpect 1.1.14 the variable corresponding to the low/high gain setting is twice of the previous value, meaning 5.7 means high gain setting (2.8 before).

### 3.5.2 Setting the Dynamic Range

The **Dynamic Range** is a software-only setting that assigns an energy in kilo-electron-Volts (keV) to an X-ray voltage pulse that spans roughly 50% of the ADC input range, a practical measurement limit.

Along with the MCA Bin Width, it determines the energy scale of the MCA spectrum, i.e. the MCA bin size (eV/bin).

The **Dynamic Range** setting should correspond to the highest measurable energy, respective of the detector, preamplifier and experimental conditions. A typical X-ray dynamic range is 40 keV or 80 keV, though some AP3 detectors intended for low-energy X-rays may work best with the minimum 20 keV setting. At very high count rates a larger Dynamic Range setting can improve throughput. Because this is a software-only setting, it is applied immediately upon selection from the drop-down list.

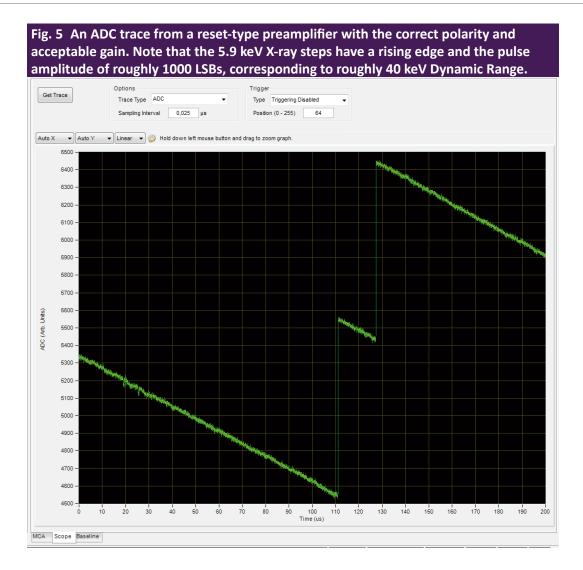
### 3.5.3 Setting the Base Gain

The Base Gain setting, associated with the GENSET, in fact combines the coarse analog Switched Gain and Digital Base Gain acquisition values into a single 'gain knob' with a range of 1-100. It should be set according to the dynamic range of the input signal: large enough that electronic noise is sufficiently digitized, but small enough that the largest X-rays of interest fit well within the ADC input range.



# **NOTE**

Setting the Base Gain too low will result in insufficient digitization of the electronic noise, and thus degraded energy resolution, because optimal energy resolution relies on noise averaging. On the other hand, setting the Base Gain too high will result in higher deadtime and the attenuation of the high energy X-ray peaks, because pulses with larger heights are more likely to force the ADC signal out-of-range, and such events cannot be processed into the spectrum.



As a rule of thumb, the largest X-rays of interest should span no more than 50% of the ADC input range.

The default **Base Gain** setting serves as an adequate starting point for most detectors. If the Preamplifier Gain is known, use the equation below to choose the preliminary **Base Gain** setting.

#### **SCOPE TOOL**

Use the **Scope** tool to check the **Base Gain** setting. You should have already verified the signal polarity, such that pulses are displayed with a rising edge as described in §3.4.2. For best results the X-ray pulses with an energy equal to the Dynamic Range should be digitized at roughly 50% of the ADC range, or 8000 out of 16,384 least-significant-bits (LSBs). X-rays with other energies should of course be scaled accordingly.



#### 3.5.4 MCA Format

The DDP2 MCA format is quite flexible, with adjustable **Number MCA Bins** ranging up to 8192, and adjustable granularity via the **MCA Bin Width** setting. The DSP doesn't constrain the relationship between these settings, so it's possible to define a spectrum that exceeds the practical limits of the ADC, i.e. such that the MCA energy range significantly exceeds the **Dynamic Range**, which should be avoided. As a rule-of-thumb, the product of **Number MCA Bins** and **MCA Bin Width** should not exceed 8192.

Tab. 2 Bin Size and Energy Range as a function of Number MCA Bins and MCA Bin Width, with a Dynamic Range of 40 keV.  Note that the product of Number MCA Bins and MCA Bin Width is always 8192 or less.						
Number MCA Bins	MCA Bin Width	Bin Size	Energy Range			
8192	1	5 eV	40.96 keV			
8000	1	5 eV	40.00 keV			
4096	1	5 eV	20.48 keV			
4000	1	5 eV	20.00 keV			
4096	2	10 eV	40.96 keV			
4000	2	10 eV	40.00 keV			
2048	1	5 eV	10.24 keV			
2000	1	5 eV	10.00 keV			
2048	2	10 eV	20.24 keV			
2000	2	10 eV	20.00 keV			
2048	4	20 eV	40.96 keV			
2000	4	20 eV	40.00 keV			

When the product equals 8000, the energy range of the MCA spectrum is exactly equal to the **Dynamic Range**, corresponding to voltage pulses that span 50% or less of the ADC input range, a practical measurement limit.

### Energy Range = Number MCA Bins · eV/Bin

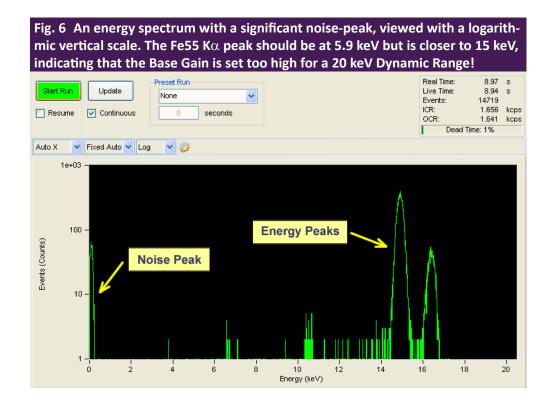
A few examples are shown in Table 4 above, all with the Dynamic Range equal to 40 keV.

Which setting is the best depends on the required bin size, energy range and spectrum file size for a given application.

Note that the default setting is 4096 bins with MCA Bin Width equal to 1.

- 1. First select the desired Number of MCA Bins.
- 2. Set the MCA Bin Width such that the product is less than or equal to 8192.
- 3. Click [Apply] to download the new settings to hardware.
- 4. Click [Save] once you have verified the settings.





# 3.6 Spectrum Acquisition

At this point the **Polarity, Base Gain, Dynamic Range, Number MCA Bins** and **MCA Bin Width** should have been set as described in § 3.4 and § 3.5 above. Before saving the GENSET settings, however, the Base Gain should be calibrated from an actual energy spectrum.

Proceed as follows:

1. Click on the MCA tab.

The **MCA** tab displays the distribution of measured pulse-heights and thus, after calibration, the energy spectrum of the incident photons.

2. Click the [Start Run] button to begin a data acquisition run.

If the **Continuous** checkbox is selected, the display will refresh automatically. Otherwise data will only be displayed after clicking the [Update] button and/or after the run is stopped.

An uncalibrated energy spectrum should now be displayed. Click [Stop Run] to end the spectrum acquisition run. A noise peak near channel zero (0) might be displayed if the gain is set too high or a threshold is set too low.

If the noise peak overwhelms the energy peak, or if no data is displayed it is likely that the Polarity and/or Base Gain has not been set properly—please review §3.4 and §3.5 above before continuing.



#### 3.6.1 ROI Selection

In order to calibrate the energy we must first designate the calibration peak with a Region of Interest (ROI). By default the ROI table should display as in Fig. 7 A.

1. Click on the Add New Row icon to add the first ROI.

Up to sixteen (16) ROIs can be added, with the Mean, FWHM, OCR and total number of Events displayed for each.

- 2. Right-click in the spectrum display of the MCA tab.
- 3. Select Place Cursor 1.
- 4. Use the left mouse button to drag the cursor within the desired peak, zooming in if necessary using the mouse shift-click + drag operation.

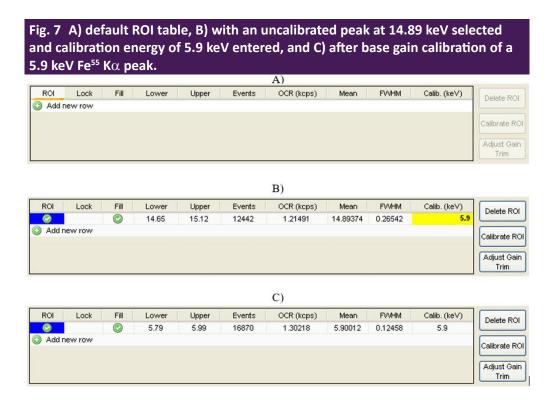
Hint: right-click and select Full Scale to display all data.

- 5. Right-click on cursor 1.
- 6. Select Auto ROI.

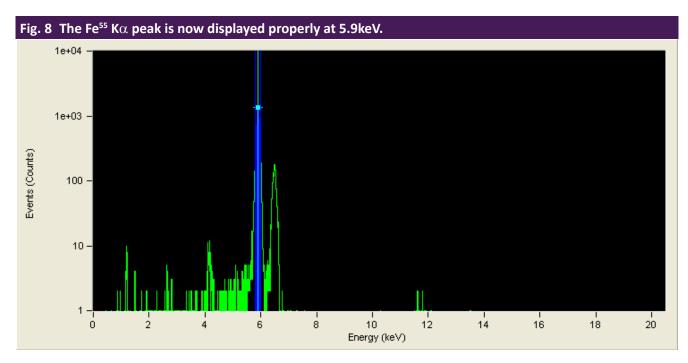


#### **NOTE**

If the Base Gain was modified significantly enough in step 1 above to change the coarse analog Switched Gain setting, the calibration may still be off by up to 1%. In this case, repeat as necessary to achieve the desired accuracy. Another consequence is that the thresholds may need to be re-optimized, so it's important to get the Base Gain right before proceeding to § 3.7.







A shaded region of interest should appear within the peak. If the number of counts in the peak is insufficient, the auto ROI function will not adequately select the peak.

If necessary, the ROI limits can be adjusted directly:

- Use the left-mouse click-and-drag operation or
- Edit the Lower and Upper fields in the ROI table.

The ROI table should now display as in Fig. 7 B.

The software will scale the active ROI (denoted by the check mark in the far-left column of the table) to the calibration energy. ROIs can be locked by clicking in the **Lock** column.

# 3.6.2 Base Gain Calibration

Once a known energy peak has been selected with the active ROI, as described in §3.6.1, the Base Gain can be calibrated.

At this point the **Fine Gain Trim** should be at its default value of 1.000. If this is not the case:

- 1. Reset the **Fine Gain Trim** in the PARSET area of the Acquisition tab to 1.000.
- 2. Click the [Apply] button below.
- 3. Enter the energy of selected peak in keV units in the Calib. (keV) field of the ROI table.
- 4. Click the [Calibrate ROI] button to automatically adjust the Base Gain. Note that the Base Gain was modified as a result.
- 5. Click the [Start Run] button to acquire more data.

Note that the spectrum should now be calibrated as in Fig. 7C. If the ROI is properly adjusted, the **Mean** field in the **ROI** table should match the calibration energy entered as in Fig. 7C.



Once you are satisfied with the MCA settings and energy calibration, click the [Save] button in the GENSET area of the **Acquisition** tab.

# 3.7 Peaking Time (PARSET) Optimization

For each of the twenty-four **Peaking Time** values the DSP stores a complete set of all related spectrometer parameters into non-volatile memory, i.e. into the corresponding PARSET. The 24 parameter sets (PARSETs) are first optimized and saved to the on-board non-volatile memory.

Subsequent selection of an optimized **Peaking Time** retrieves all relevant digital filtering and peak inspection parameters (e.g. gap time, thresholds, pileup inspection interval, etc.). This functionality is targeted at embedded systems: the configuration and optimization procedures can be performed in the lab using the ProSpect software, such that only a small command set is required within the embedded system itself, e.g. start run, stop run, change PARSET (peaking time), etc.



The configuration process needs only be performed once, though of course the parameter sets can later be modified.

**Peaking Time** (PARSET) selection and the most commonly used parameter settings are accessed directly from the **Acquisition** tab of the **Settings** panel.

- » Click [Edit Filter Parameters] to access less frequently used parameters.
- >> Select the desired **Peaking Time** from the drop-down list.



The following sections describe the process of selecting and storing the individual parameters for one peaking time.

### 3.7.1 Threshold Settings

Three thresholds can be used simultaneously to distinguish noise from X-ray events. Whereas noise goes into the baseline distribution, X-ray events go into the energy spectrum.

Each of these thresholds has its own balance of timing vs. noise performance.

- The fast-filter **Trigger** threshold achieves the best pulse-pileup rejection.
- The slow-filter **Energy** threshold can be used to detect the lowest energies.
- The intermediate-filter **Baseline** threshold is somewhere in the middle.

Thresholds can be individually disabled by setting them to zero (0).

The thresholds are typically the most important PARSET settings to get right. By default they are set conservatively, however, better performance will be achieved when the thresholds are set as described below.

We recommend saving the PARSET after each threshold is verified, by clicking the [Save] button.

Finally, note that if the Base Gain is subsequently changed by a significant amount, i.e. by enough to change the coarse analog Switched Gain, the thresholds must be re-optimized and the PARSET saved again. For this reason it's important to first get the Base Gain right as described in §3.6.2.

#### 3.7.1.1 Disable the Slow Threshold

By default the **Energy** threshold is disabled, and it should be disabled, i.e. set to zero (0), in nearly all cases.

Although its excellent noise reduction also allows detection of the very lowest energy X-rays, its slow response precludes an accurate determination of deadtime. This results in both degraded pulse pileup inspection and an error in the input count rate calculation. The **Energy** threshold should thus be used only when low-energy X-rays of interest are present that can't otherwise be detected using the other thresholds, and only then with the understanding that pileup inspection for such events is marginal at best.

# 3.7.1.2 Trigger Threshold

By default the Energy threshold and the Baseline threshold should be disabled, i.e. set to zero (0).

If this is not the case

- 1. Set both values to zero now.
- 2. Click [Apply].

Depending on the system, an appropriate **Trigger** threshold value is provided.

- 3. Edit the value as necessary.
- 4. Click [Apply].
- 5. Click [Start Run] to acquire data in the MCA tab.
- 6. Click [Stop Run].

If the noise peak is NOT displayed:

- 7. Reduce the **Trigger** threshold by a factor of 2.
- 8. Repeat steps 5 to 7 until the noise peak is visible.
- 9. When the noise peak is displayed, increase the Trigger threshold in smaller increments.



- 10. Repeat until the noise peak is eliminated.
- 11. Take note of the input and output count rates (ICR and OCR) for the next section.
- 12. Click the [Save] button in the PARSET area of the **Acquisition** tab.

#### 3.7.1.1 Baseline Threshold

Disable the Baseline and Energy thresholds (set to zero (0)). The Trigger threshold has been set to a good value before as described in the previous chapter.

In most cases a starting value of roughly 100 for the **Baseline** threshold is appropriate.

- 1. Edit the value.
- 2. Click [Apply].
- 3. Click [Start Run] to acquire data in the MCA tab.
- 4. Click [Stop Run].

If the noise peak is NOT displayed:

- 5. Reduce the **Baseline** threshold by a factor of 2 and
- 6. Repeat steps 3 to 5 until the noise peak is visible.
- 7. When the noise peak is displayed, increase the **Baseline** threshold in smaller increments.
- 8. Repeat until the noise peak is eliminated.

Note that in most cases the **Baseline** threshold will have very little effect on the input and output count rates.

9. Click the [Save] button to save the new Baseline Threshold to the current PARSET.

### 3.7.2 Fine Gain Trim

Now we are ready to trim the gain for this peaking time.

Remember, the Base Gain was stored in the GENSET.

The Fine Gain Trim, or per-peaking-time calibration, is stored in the PARSET. There is a Fine Gain Trim value stored for every PARSET/GENSET combination, allowing for a unique overall gain setting for each combination.

- 1. Select a known peak in the MCA spectrum.
- 2. Enter its energy in the Calib. (keV) field of the ROI table, if it hasn't been entered already.

Make sure the selected ROI is active, i.e. it has the green check mark in the left-most column of the table!

3. Click the [Adjust Gain Trim] button to automatically adjust the Fine Gain Trim. Note that the Fine Gain Trim has been modified but the Base Gain has not.



NOTE

The Overall Gain also includes the Fine Gain Trim value that is associated with each Peaking Time, i.e. stored in each PARSET, to maintain the gain calibration on a per-peaking-time basis, as described in § 3.7.3.



- 4. Click the [Start Run] button to acquire more data. Compare the Mean energy in the ROI table to the calibration energy entered.
  - 5. Repeat steps 3 and 4 until the fields match the required precision.
  - 6. Click the [Save] button to save the Fine Gain Trim to the current PARSET.

# 3.7.3 Optimization of the Remaining PARSETs

We're now ready to repeat the above process for each of the remaining twenty-three PARSETs, or perhaps only those that will be used. Set and verify the thresholds and then save each PARSET to non-volatile memory:

- 1. Write down the Trigger and Baseline threshold settings for your optimized PARSET.
- 2. Select the next Peaking Time from the drop-down list.
- 3. Enter the values from step 1 above.
- 4. Click [Apply].

Don't re-optimize the Trigger threshold unless the Fast Trigger Filter Peaking Time (aka FASTLEN) has changed. By default all PARSETs have a Fast Trigger Filter Peaking Time of 50 ns (FASTLEN=2),

Note that the Fast Trigger Filter Peaking Time is displayed in the Edit Filter Parameters dialog as described in § 3.7.4.

If you are changing from a shorter Peaking Time to a longer one, the Baseline threshold can likely be reduced a bit. Optimize the Baseline threshold as described in §3.7.1.1.

- 5. Calibrate the Fine Gain Trim as described in §3.7.2.
- 6. Repeat steps 1-5 above for each remaining Peaking Time, making sure to [Save] often.

Now you have completed the basic configuration and optimization!

If you do not achieve satisfactory performance after following the above procedure, continue reading § 3.7.4 below, which includes:

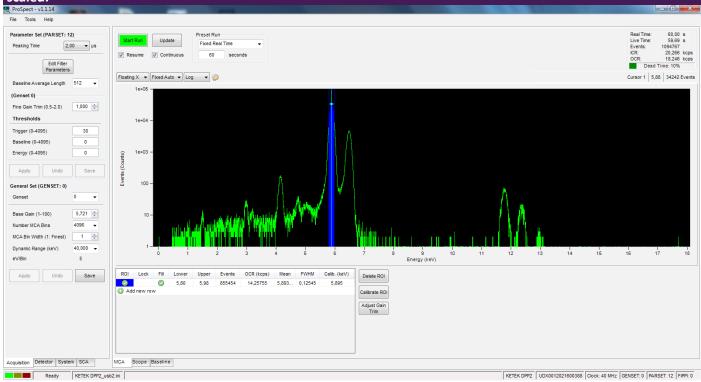
- Adjusting the slow gap time for longer preamplifier rise times, as described in §3.7.4.1.
- The Peak Capture Method at short peaking times may need adjustment, as described in §3.7.4.2.
- Adjustment of the Fast Trigger Filter and pileup inspection parameters is described in §3.7.4.3.

# 3.7.4 Advanced Optimizations

See Fig. 11 for the advanced settings for the current Peaking Time. Changing any of these parameters can significantly alter the performance of VICO-DP at the selected Peaking Time.



Fig. 10 Calibrated Fe55 spectrum viewed with a logarithmic vertical scale. An ROI has been created and calibration energy entered, and thus the horizontal axis of the MCA and the measured centroid and FWHM have been scaled.

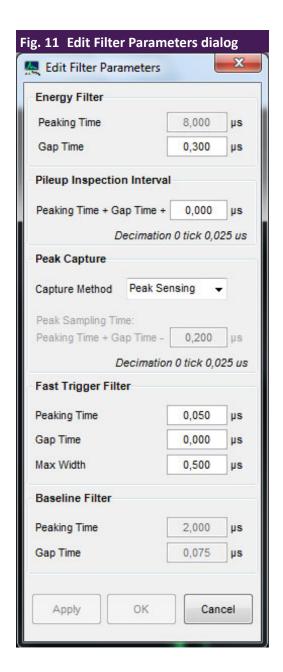


- 1. Go to the **Acquisition tab** in the Settings Panel. See Fig. 10.
- 2. Click the [Edit Filter Parameters] button in the PARSET area of the Settings Panel.

This dialog displays the parameters that control the digital filtering algorithm.

- 3. Make sure the desired Peaking Time is selected from the drop-down list.
- 4. Click [Edit Filter Parameters] to open the Edit Filter Parameters dialog.
- 5. Edit the parameters of interest (e.g. Energy Filter Gap Time, Capture Method, Fast Trigger Filter Peaking Time, etc.).
- 6. Click [OK] to apply the changes and close the dialog, or click [Apply] to apply the changes but keep the dialog open for further editing.
- 7. Click [Start Run] to acquire data for comparison in the MCA tab.
- 8. Click [Stop Run].
- 9. [Save] the PARSET to store the modified parameters to non-volatile memory such that they will be retrieved the next time the Peaking Time is selected.





# 3.7.4.1 Preamplifier Rise Time: SLOWGAP

The **Energy Filter Gap Time** is visible as the 'flat-top' region of the energy filter output trapezoid. SLOWGAP is typically set such that the flat-top interval is longer than the longest rise time of the preamplifier output pulses by at least one sampling interval:

# Energy Filter Gap Time = SLOWGAP ⋅ sampling interval > rise time

In special cases where the very highest output count rates are desired, and perhaps at the expense of energy resolution or peak shape, the user may wish to set the gap time to be significantly less than the SDD's rise time.

The rise time is easily measured using the Scope tool:

- 1. Select ADC.
- 2. Set Sampling Interval to the minimum value by entering "0".
- 3. Click the [Get Trace] button.
- 4. Use the cursors to zoom in on an X-ray pulse, as in below.



Fig. 12 In this example plot the rise time is ~200 ns as indicated in the dX=0.20 field at the upper right corner. Get Trace Trace Type ADC Type Triggering Disabled Sampling Interval Position (0 - 255) 0.025 Floating X ▼ Floating Y ▼ Linear ▼ Delto Hold down left mouse button and drag to zoom graph. Cursor 1 | 33,175 | 12040 Events | dX=0,20 | dY=994 12950 12900 12850 12800 12750 12700 12650 12600 (Arb. Units) 12550 ADC 12500 12450 12400 12350 12300 12250 12200 12100 MCA Scope Baseline

In the example plot (Fig. 12) the cursors are used to zoom in and measure the preamplifier 0-100% rise time.

If the input signal displays a range of rise times, as in the case of ballistic deficit (large SDDs > 20mm<sup>2</sup>), the slow filter gap time should be extended to accommodate the longest rise times.

The Energy Filter Gap Time is constrained by the relationship between the slow energy filter and the intermediate baseline filter. The baseline filter length (BASELEN) and gap (BASEGAP) are always constrained to be exactly ½ or ¼ the energy filter length (SLOWLEN) and gap (SLOWGAP), respectively, depending on the Peaking Time.

This means that the energy filter length and gap increment, or units, must be either 2x or 4x the clock period, as shown in Table 5.



### **NOTE**

ProSpect automatically enforces this relationship: It will round the user value up or down as necessary when the [Apply] or [OK] buttons are pressed. The relationship can be determined by the parameter BFACTOR:

"SLOWLEN= " "2" ^"(BFACTOR+1)" " \* BASELEN"



### **NOTE**

The Baseline Filter Peaking Time and Gap Time are displayed at the bottom of the Edit Filter Parameters dialog, but cannot be edited.



Tab. 3 The Energy Filter Gap Time (SLOWGAP) increment depends on the Peaking Time and clock speed.. 
Peaking Time Range | BFACTOR | SLOWGAP increment (with 40MHz clock) 
0.1 to  $0.6 \, \mu s$  | 0 | 2x (50 ns) 
0.8 to 24  $\mu s$  | 1 | 4x (100 ns)

### **Example:**

If the preamplifier rise time is 120 ns and the Peaking Time is 8  $\mu$ s, BFACTOR=1 and SLOWGAP has an increment of 4x the clock period.

With a 40MHz clock the SLOWGAP increment is 100 ns, and the correct setting is 200 ns.

- 1. Open the Acquisition tab.
- 2. Click the [Edit Filter Parameters] button.
- 3. Edit the Energy Filter Gap Time as necessary.
- 4. Click [OK].
- 5. Click [Save] to save the new value to the PARSET in the PARSET area of the Acquisition tab.

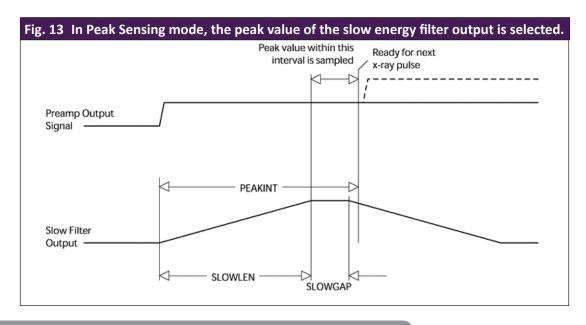
# 3.7.4.2 Peak Capture Method: Peak Sensing vs Peak Sampling

Two peak capture methods are supported by the VICO DP hardware. In general, the default Peak Sensing mode is recommended: it is 'automatic' and thus easier to use, and achieves the best pulse-height measurement in most cases.

At very short peaking times, and especially when the user sets the Energy Filter Gap Time to less than the preamplifier rise time, the Peak Sampling mode may yield better results. The precise setting has a strong effect on energy resolution and should be determined empirically for each new detector.

### **PEAK SENSING**

In this mode, the energy filter output is monitored over a finite interval of time, and the maximum value within that interval is selected.





The interval is set automatically, based on the values of the parameters SLOWLEN and PEAKINT. PEAKINT is also a pileup inspection parameter, as will be discussed in further detail in § 3.7.4.3.

For **Peak Sampling** mode, the slow filter output is instead sampled a fixed time after the X-ray is detected.

Perform the following steps:

- 1. Select the desired peak capture method.
- 2. Click [OK].
- 3. In the PARSET area of the Acquisition tab, click [Save] to save the modification to the PARSET.

#### 3.7.4.3 Pileup Inspection: FASTLEN, FASTGAP, MAXWIDTH, PEAKINT

Undetected pulse-pileup results in unwanted pileup peaks in the spectrum. Pileup peaks in the spectrum can often be identified by noting that the apparent energy of the pileup peak is the sum of the energies of the piled-up X-ray pulses.

Two pileup inspection methods are utilized in the VICO-DP:

- Fast pileup inspection monitors the pulse width of the fast filter output, or more specifically, the time during which the Trigger threshold is exceeded.
- Slow pileup inspection monitors the time between two successive threshold crossings.

The fast filter is controlled by the parameters FASTLEN and FASTGAP. It is not necessary to set the FASTGAP in relation to the preamplifier rise time, in fact it is set to zero (0) by default, and should left so in nearly all cases.

For the limiting case of a preamplifier rise time equal to zero, the fast filter produces a trapezoid of maximum width:

Max Width  $\geq$  (FASTGAP + 2 · FASTLEN) · sampling interval

The parameter MAXWIDTH sets the **Max Width** limit for acceptable events, in units of the sampling interval (i.e. 25 ns for 40 MHz). The fast filter trapezoidal waveform convolutes the preamplifier rise time  $t_R$  with FASTLEN and FAST-GAP, and thus MAXWIDTH should be increased accordingly:

MAXWIDTH  $\geq$  FASTGAP + 2 · FASTLEN + (t<sub>n</sub>/sampling interval)

The slow **Pileup Inspection Interval** is the time between two successive fast filter pulses. PEAKINT sets the minimum separation. By default it is automatically set to:

Pileup Inspection Interval = Peaking Time + Gap Time

Or

PEAKINT = SLOWLEN + SLOWGAP

...and should be left so in nearly all cases. Lower settings will increase the magnitude of pileup peaks.



Higher settings may in some special cases improve pileup rejection, but typically it will have no effect on pileup and will always increase the dead-time-per-event and thus reduce throughput. Click the **Edit Filter Parameters** to open the **Edit Filter Parameters** dialog.

- 1. Edit Max Width as necessary.
- 2. Click [Apply].

In ProSpect, the **Pileup Inspection Interval** is defined as an offset from its default value, per above equation. The default offset is thus zero.

To increase the interval,

- 1. Enter a positive number.
- 2. Click [Apply].
- 3. Start a new run and re-examine the ratio of the identified pileup peak to its associated energy peak.
- 4. After the settings have been optimized, click the [Save] button.

Remember that individual settings are stored and retrieved for each Peaking Time!

# 3.7.5 Viewing the Run statistics

The run statistics are displayed in the upper right corner of the MCA tab. See figure Fig. 10.

**Real Time** and **Live Time** are displayed in seconds; **ICR** (input count rate) and **OCR** (output count rate) are displayed in kilo-counts-per-second. The total number of **Events** in the spectrum and the **Dead Time** percentage are also displayed.

# 3.7.6 Livetime and Deadtime

The displayed **Live Time** is NOT the live time of the energy filter, rather it is a measurement of time that the triggering filter remained under threshold. This measurement, along with the number of times the threshold was crossed, or Fast Peaks, is used to calculate the input count rate.

ICR = Fast Peaks / Live Time

The Live Time of the energy filter is not displayed in software, but can be calculated according to:

Energy filter Live Time = Real Time ⋅ OCR / ICR

The **Dead Time** percentage is displayed in software, calculated as:

Dead Time = 1 - OCR/ICR

# 3.7.7 Saving a Spectrum

The spectrum export function produces a text file with a descriptive header and a list of values, i.e. the number of counts recorded in each MCA bin. The energy-per-bin and run statistics are included in the header.



To save a spectrum,

- 1. select Save MCA Data... from the File menu.
- 2. After the prompt appears, enter the file name.
- 3. Select a location to save the file.

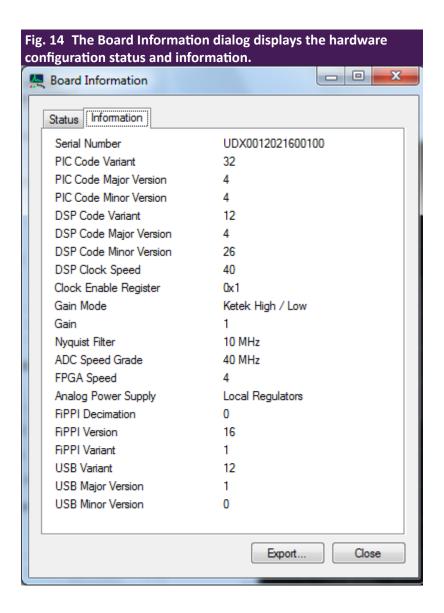
# 3.8 Diagnostics

### 3.8.1 Board Status and Information

The **Board Information** dialog is used to display basic information about the configuration and status of the VICO-DP hardware.

- 1. Go to the Tools menu.
- 2. Select Board Information... to open the dialog.
- 3. Click the Status tab to display the current status of the PIC microcontroller and DSP.

If no error conditions have been detected all values should read zero.





- 4. Click the **Information** tab to display the current hardware and firmware configuration, as displayed in Fig. 14.
- 5. Click the [Export ...] button to store all info, i.e. status, history and configuration information, to a text file.

This text file is useful to KETEK support staff when attempting to diagnose hardware and/or firmware problems.

# 3.8.2 Log Files

- 1. Go to the Tools menu.
- 2. Select **Diagnostics...**to access the software application log files.

The ProSpect tab displays the contents of ProSpect.log, a log of high-level GUI operations.

The Handel tab displays the contents of ProSpect handel.log, which contains low-level information.

Both files are saved to the default location:

C:\Users\<username>\AppData\Roaming\XIALLC\ProSpect\logs

The log files, and particularly the Handel log file, can be helpful to KETEK support staff when attempting to diagnose hardware and/or firmware problems.

### 3.8.3 The Scope Tool

The **Scope** tab displays 8,000 points of the selected digital signal vector, to be used as a diagnostic tool during setup and debugging.

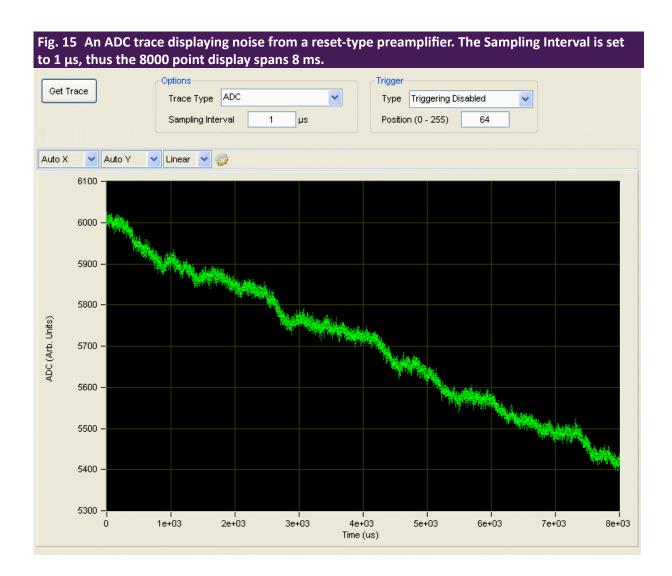
- The **Trace Type** drop-down list selects the source vector.
- The Sampling Interval field controls the time interval between individual points. The minimum value is the ADC sampling interval, e.g. at 40 MSPS the minimum value is 25 ns, and results in a displayed period of 200 μs.
- The **Trigger Type** drop-down list selects the scope trigger source (which is independent of the event trigger for data acquisition mode). We recommend setting **Trigger Type** to **Fast Trigger** in nearly all cases.
- The Position field determines the horizontal position of the triggered event. Its value ranges from 0 to 255, with 128 putting the triggered event at the center of the displayed trace.

In order to make sense of the **Scope** data, it's important to distinguish X-ray pulses from noise, and for reset-type preamplifiers we must also identify preamplifier resets and VICO-DP tracking steps in the display.



## 3.8.3.1 Identifying Noise

Fig. 16 shows an ADC trace displaying only noise. In this case a significant low-frequency noise component (i.e. in the 100Hz – 1kHz range) is displayed, in addition to high-frequency noise.



High and low-frequency noise are distinguished relative to the spectrometer filter length (i.e. slow filter peaking time): noise components with a period much longer than the peaking time are referred to as low-frequency, and are filtered out through baseline averaging; those with a period much shorter are referred to as high-frequency, and are filtered out through integration in the energy filter itself.

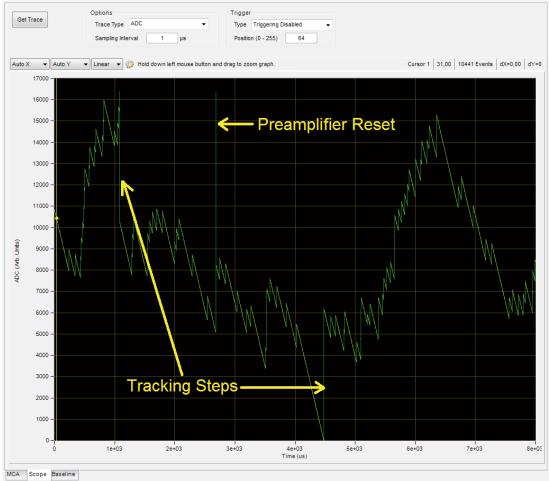
### 3.8.3.2 Preamplifier Resets and Tracking Steps

Additional signal transients are present for pulsed-reset preamplifiers, and they will often be visible in the ADC and other trace types.

Reset-preamplifiers produce a large corrective reset step when the large-signal 'staircase' waveform reaches its limit. This reset transient varies for different preamplifiers, both in the duration and in other signal characteristics, e.g. rise time, charge-injection, overshoot and settling time.



Fig. 16 There are approximately 120 X-rays displayed for a reset-type detector. The preamplifier reset briefly sends the ADC out-of-range high. The three tracking steps are introduced by the VICO-DP analog signal conditioner (ASC) in response to the signal first drifting out-of-range low twice, then out-of-range high once.



Other transients, called tracking steps, are due to the VICO-DP itself. The analog signal conditioner (ASC) dynamically maintains the signal within the ADC input range by introducing large voltage steps of approximately one half the ADC range (i.e. pushing the signal from the ADC boundary to near mid-range).

The resulting transient tracking steps are qualitatively similar to the step produced by an X-ray, but occur with both rising and falling edges.



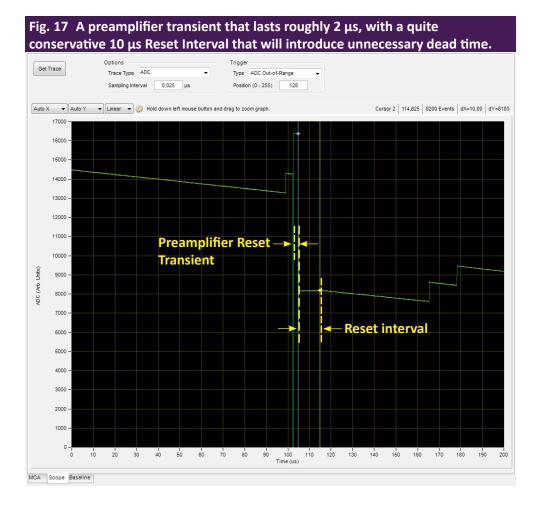
**NOTE** 

The individual X-ray steps are in the range 1000 vertical units, which is approximately 6% of the ADC input range. We frequently refer to X-ray step heights in terms of ADC percentages.

Tracking steps can be identified by noting that the transients originate near the ADC minimum (0) or maximum (16384) and terminate near mid-range (6000 to 10000).

One preamplifier reset and three tracking steps are displayed in Fig. 17.





### 3.8.3.3 The Preamplifier Reset Interval

The **Reset Interval**, expressed in units of microseconds ( $\mu$ s), determines the wait time after the preamplifier reset transient during which the spectrometer is disabled.

A proper setting ensures that the reset transient doesn't pollute the baseline or spectrum, and that excessive dead time is not incurred.

- 1. In the **Scope** tab, select **ADC** from the **Trace Type** drop-down list.
- 2. Set the **Sampling Interval** to the minimum value, i.e. enter "0".
- 3. Select ADC Out-of-Range for the Trigger Type and
- 4. Enter 128 in the Position field.
- 5. Click the [Get Trace] button to acquire data.

We are triggering on the ADC going out of range, thus we should see either a tracking step or a preamplifier reset at the center of the plot. The tracking steps can be identified as starting at roughly 0 or 16384, and quickly terminating near the center of the ADC range.

Preamplifier reset transients look different: they start anywhere in the ADC range and they often go out of range high and low, and/or stay out of range for a while.

If you're having trouble identifying preamplifier resets, try setting the **Reset Interval** to a value larger than the default 5 µs, so that the resulting flat area after the transient can clearly be observed as in Fig. 17.

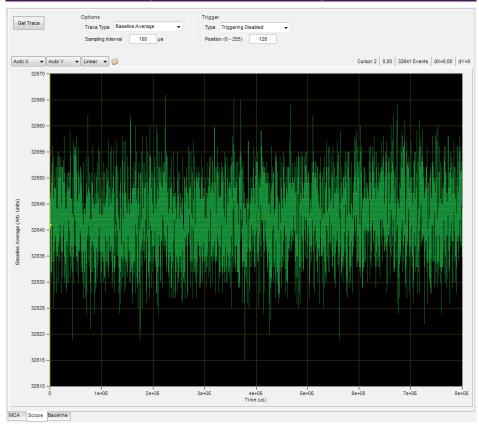
The idea is to set the **Reset Interval** such that the ADC signal goes flat for a finite but brief period of time, e.g.  $2 \mu s$ , after the preamplifier transient.



The **Reset Interval** setting can be modified in the **Detector** tab:

- 1. Enter the Reset Interval in microseconds.
- 2. Click the [Apply / Save] button.

Fig. 18 A good Baseline Average trace. Note that the zero point has been shifted to 32768 in the plot area because this is a signed vector.



- 3. As a final check, select **Baseline Average** from the **Trace Type** drop-down list.
- 4. Acquire a trace at 100 μs **Sampling Interval**.

The ideal trace should look like white noise, as in Fig. 18. Significant transients and/or periodic signals warrant a more conservative Reset Interval setting.



**NOTE** 

All of the Trace Type signals except for ADC and ADC Average are signed 2's complement vectors.

# 3.8.4 Baseline Acquisition

Proper baseline acquisition and averaging is critical to the VICO-DP's performance. The baseline is the output response of a digital filter when no photons are present. As is standard in pulse-processing applications, baseline measurements are averaged over a time interval value that is sufficiently long to eliminate high-frequency noise, but short enough that the average tracks actual variations in the preamplifier output independent of incident photons. This average is subtracted from the instantaneous measurements of step-pulse heights, yielding improved threshold stability with count rate and the improvement in noise associated with the double-correlated pulse-height measurement.



Tab. 4 Trace Type Definition					
Trace Type	TRACETYPE	Description			
ADC	0	The raw ADC samples (with optional inversion according to the Polarity setting)			
ADC Average	1	A running average of the ADC samples, where the average length is equal to the Baseline Average Length			
Fast Filter 2		The fast trigger filter output after fast baseline subtraction, scaled to the same units as the Trigger Threshold			
Raw Intermediate Filter	3	The output of the intermediate baseline filter, before baseline subtraction			
Baseline Samples	4	Samples of the raw intermediate filter when at baseline			
Baseline Average	5	A running average of the Baseline Samples, where the average length is equal to the Baseline Average Length, that is subtracted from both the intermediate and energy filters			
Scaled Intermediate Filter	6	The intermediate baseline filter after baseline subtraction and scaling by the digital gain coefficient			
Raw Energy Filter	7	The output of the slow energy filter, before baseline subtraction			
Scaled Energy Filter	8	The slow energy filter after baseline subtraction and scaling by the digital gain coefficient			

Baseline acquisition is controlled by the Baseline Threshold, the number of samples averaged, or Baseline Average Length, and the Reset Interval, the time interval after each preamplifier reset during which data acquisition is disabled.

The baseline is displayed in two ways: a histogram of baseline samples, i.e. the distribution of instantaneous baseline measurements, is displayed in the Baseline tab. With proper settings, the baseline histogram is an accurate representation of system noise.

The **Baseline Average** in the **Scope** tab displays the computed average as a function of time.

Theoretically the distribution of baseline samples is Gaussian with a constant average value.

Real world detectors and preamplifiers generate several types of nonlinearities in the baseline distribution, and the mean value may wander with temperature, the rate of incident photons, etc.

These effects can be addressed by reducing the number of samples in the average, or the Baseline Average Length, as described in § 3.8.4.2, or perhaps by increasing the detector **Reset Interval** setting, as described in § 3.8.3.3.



# **⚠** NOTE

The default setting, i.e. conservative Trigger Threshold setting with other thresholds disabled, provides little discrimination against low-energy X-ray events, thus the baseline histogram may include the soft X-ray regime of the spectrum as well as the noise peak, as in Fig. 19. Nonetheless at low to moderate event rates the vast majority of the measurements still fall on the noise peak as intended, and the baseline average is still largely functional. At higher rates the average will be increasingly corrupted by the growing energy component in the average, resulting in a rate-dependent shift in measured event pulse-heights. This degradation disappears when the baseline threshold is set correctly.



Fig. 19 Baseline histogram acquired with very conservative threshold settings. The vertical axis is displayed on a logarithmic scale. Note the noise peak at zero, and the significant energy soft X-ray component to the right.

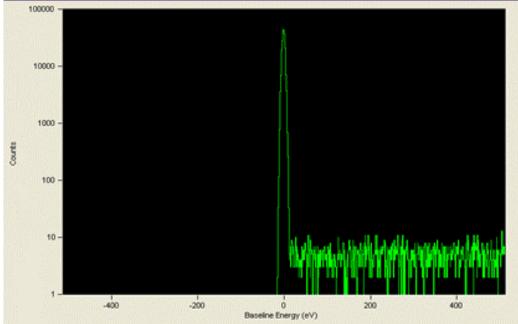


Fig. 20 A very clean baseline histogram with thresholds set correctly—the noise peak is isolated and Gaussian in appearance.

### 3.8.4.1 The Baseline Threshold

The **Baseline Threshold**, which has a 12-bit range, is used both to acquire valid baseline samples and to trigger on X-ray events in the intermediate filter. An aggressive setting can result in better sensitivity to low-energy X-rays.

An overly-aggressive setting can interfere with baseline sampling and introduce a noise peak in the spectrum.



The **Baseline Threshold** is disabled by default (thresholds can be disabled by setting them to 0). See § 3.7.1.1 for instructions on setting the **Baseline Threshold**.

Follow this procedure:

- 1. Open the Baseline tab.
- 2. Click [Get Baseline] to refresh the histogram display.

If the Baseline Threshold is set too high, part of the energy spectrum may be displayed in the baseline distribution as in Fig. 19. If the Baseline Threshold is set correctly, only the noise peak should be visible. For a high quality detector and preamplifier, the noise peak should resemble a symmetric Gaussian distribution as shown in Fig. 20.

### 3.8.4.2 Number of Samples in the Baseline Average

Real-world detectors and preamplifiers can produce a baseline that varies over time or voltage. A time-variant, or wandering, baseline can be mitigated by reducing the number of samples averaged, or **Baseline Average Length**. It is part of the PARSET, and thus stored on a per-peaking-time basis. Reducing the number of samples allows the average to track with the real variations in the baseline, and thus yields better accuracy. Conversely, fewer samples in the average results in less noise reduction, and thus less precision in the pulse-height measurement.

- 1. In the **Scope** tab, select **Baseline Average** from the drop-down list.
- 2. Click the [Get Trace] button.

A large Sampling Interval, e.g. 10-100 μs, is best, because the baseline itself is only sampled periodically.

Each point in the display represents the averaged baseline at that instant. The number of baseline points included in the average is determined by the DSP parameter BLFILTER according to the following equation:

Baseline Average Length = 
$$\frac{32768}{BLFILTER}$$

BLFILTER defaults to 64 or 128, thus the default **Baseline Average Length** is 512 or 256. We have found this to be a good balance for most detectors over a range of peaking times. At very high rates, and alternatively for lower quality detectors with significant real variations in the baseline, it is best to reduce the **Baseline Average Length**.

At shorter peaking times it is often advantageous to average more points because each individual point contains a larger noise component than for longer peaking times.

- Open the Acquisition tab.
- 2. Select the desired Baseline Average Length from the drop-down list and click [Apply].
- 3. Click [Get Trace] in the **Baseline** tab to refresh the display.
- 4. Repeat steps 1 3 as necessary.
- 5. When the desired performance has been verified, click [Save].

Remember that individual settings are stored and retrieved for each Peaking Time.



# 4 Contact

If you have any questions regarding this or any of our products please do not hesitate to contact us via e-mail or phone.

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