ATEip
AUTOMATIC TEST EQUIPMENT IP

EFx3

Product Specification
Revision 2.0

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Part Number: EFxSPECB3.1-.2.0semi

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1.0 Introduction to the ELECTRIC INSPECTION; EFx 'Elektrische Fotografie / Electric Image

ATEip's Electric Inspection system is a high-performance test platform targeted for any electronics, semiconductors and electric circuits. The new patented (DE 10 2018 217 406, US_Patent-11_320_477B2) EFx technology predestined for quality assurance in high volume and high throughput production.

Based on the EFx Technology ('Elektrische Fotografie' – electrical image; Impedance snapshot) the system can analyze PCB's network, including all electrical parameters completely. The circuit schematics is seen as electric functionality.

For all nodes of the electronic circuit the system delivers after test, the impedance.
In the test result we receive also the detailed component parameters (so called In-Circuit test).

The EFx technology force and measure voltage, current and phase simultaneously. At each contacted node a separate, independent, multi spectral AC signal is driven and measured. The results will be analyzed by a complex mathematical filter algorithm.

Each tester channel works completely autonomous and potential free. It behaves like a complete stimuli and measurement set of a traditional tester. The difference of the EFx tester is that each tester channel owns this complete set and is directly connected to the circuit under test.

The overall test time is not depending on the number of assembled components. It depends on the most time-consuming component test (e.g. big capacitor 1F). Statistical average test time is 10 ms for the complete PCB.

To optimize cost of test system ATEip offers multiplexer by 10 option. This will increase the number of channels by 10. The multiplexer is an on/off structure, which switch's only once per test, it is no cross matrix.

The EFx-FPO (Flying Prober Option) focus on Flying Prober test time and movement reduction.
The speed improvement is realized by less movements and shorter test time, because of the complex cluster tests, contacted by the number x of available flying probes.

For the functional test the innovative EFx architecture allows the complete time mapping on all nodes of the circuit and it monitors it during the function of the PCB. This provides a lot of more solutions for failure analysis of PCB.

The EFx architecture is flexible and open for future expansion. The EFx test system family is able to substitute any current, obsolete and aged tester platform.

2.0 Introduction to the EFx Test System

2.1 The Tester Hardware

2.1.1 Back-plane-less structure (Any module at any slot)

2.1.2 Number of channels is unlimited (depend on the cabinet size)

The test system is equipped with a number of the EFx-3 module. Each module contains 10 channels (testers). The number of EFx-3 modules per tester is unlimited. One EFx-3 channel contains complete instrumentation set (see 2.1.3); each channel that comply with a full tester.

2.1.3 One complete tester per channel

contains:

a. 16 Bit Voltage Source including 16 Bit Measurement (25 V)
b. 16 Bit Current Source including 16 Bit Measurement (100 mA)
c. 16 Bit Measurement Digitizer
    1. including scope function
d. 16 Bit AWG (arbitrary waveform generator)
e. Digital I/O pin
    1. Standard high voltage mode, 100 kHz (25 V)
    2. Fast mode, 31.25 MHz (5 V)
f. Floating force and sense architecture

2.1.4 Options

a. Flying Prober (FP) option
    1. EFx-3 module hardware including software and remote-control interface for flying probe test systems
    2. FP optimized ATEip SEQUENCER ELFOX application for flying probe tester cluster test. One cluster is composed by the amount of available flying probes, optimized automatic selection of the contacted cluster circuit nodes for maximum number of measured components.
b. EFx-3 Mux (Multiplexer module)
    1. The multiplexer realizes with EFx-3 module total amount of 100 channels; 10 channels (testers) multiplexed by 10
    2. Mux optimized ATEip SEQUENCER ELFOX application for multiplexer cluster test. Optimal automatic selection of connected cluster circuit nodes for maximum number of measured components.
c. EFx-3 HVB module (High Voltage Booster) option
    1. To expand voltage up to 50 V, 100 V / current range 1 A, 10 A
d. Boundary Scan function
    1. Goepel JTAG solution full integration; Goepel vector support at digital I/O
    2. Goepel RAPIDO VPC slot compatible
e. EFx-3-OBP (On board programming)
f. Scope 1 / 10 GHz; bandwidth 20MHz, resolution scalable 8 – 16bit
g. AWG 200 Ms/sec, 14bit,
h. Logic analyzer 16 channel logic analyzer 100 MHz
i. Power supply option (19” standard remote programmable power supply)

2.2 The Tester Software

2.2.1 ATEip SEQUENCER©

The ATEip SEQUENCER© is the Tester OS of the complete inspection system running under MS-Windows® 7, 8.2 or 10. It provides GUI for the Test Engineer and the Operator. It generates, displays and allow debugging of the test program flow and the results. It interfaces the complete periphery, e.g. remote control from handlings systems or in-line equipment, transferring the PCB data in serial numbers, lot numbers, measured (pass) data, failure data, complete logging data into the data base of the customer (customized adaptation t.b.d.). This software allows to integrate easily external hardware via standard protocol interfaces (RS232, USB, GPIB, Can-, I^2C-, SPi- Bus etc.)
The ATEip SEQUENCER© provides the flexibility to decide which test method should be chosen before the program is generated. It performs the EFx ELFOX software module, the functional test and it is also possible to test, singular sequential, like at the traditional ICT for one part (component) after each other. For these 3 steps complete software environment including Software Application Engineering tools and GUI for debugging and off-line programming and EFx hardware simulation are available.
To have the most flexibility, the complete hardware features with all the functionality, as described from chapter 2.3 et seq., is able to be programmed, handled and controlled separately.

2.2.2 EFx ELFOX© Electrical Inspection

The EFx ELFOX© allows to test Boards in an average time less than 100 milliseconds. Benchmark result:
- 1 EFx test (9,4ms) = 764 tests on a standard ICT (54 s).
- Exact same components were tested

The test time does not depend on how many components or how many channels are connected to the Board under Test (BUT).
The ELFOX© uses the imported CAD Data (Part list incl. TP and tolerances, netlist, TP location etc.) from the PCB design and generates automatically the test for the complete board. Multiple panel EFx test's all independent in parallel.
To increase number of channels (testers) you can add EFx-3 modules as much as you want. To configure test system with high pin count ATEip offers the multiplexer module, which Increases the number of test channels by factor 10. With a standard EFx-3 module we offer 10 independent tester structures. The multiplexer module increases channel count by factor 10. Finally, 1 EFx-3 module including multiplexer offers 100 test channels. With 10 EFx board Multiplexers you reach 1000 test channels per system.

2.2.3 EFx In-Circuit Test (EFxICT)

The EFx Hardware is equipped with a complete Tester per each channel. Like in a traditional In-Circuit Tester which offer the instrumentation only once per system or base module. The ATEip SEQUENCER© control's all circuits of the Tester. It can force voltage or current, the system is able to measure voltage or current. The traditional ICT parameter ranges are described in chapter 3. The measurement procedures are explained in detail in the programming manual.

Even the EFxICT is able to test all multiple panel boards at the same time in full parallel.

To configure test system with high pin count ATEip offers the multiplexer module, which increases the number of test channels by factor 10. On standard EFx-3 module there are offered 10 independent tester structures. The multiplexer switches these structures by factor 10. Finally, 1 EFx-3 module including multiplexer offers 100 test channels. With 10 modules you can configure a 1000 hybrid channel test system.

2.2.4 EFx Functional Test (EFxFT)

The EFx Hardware owns a complete Tester per channel. Each channel is floating and potential free. Each channel of the EFx-3 module includes
- Voltage driver +/- 12.5V, swing of 25 V
- Current driver +/-100 mA
- Digitizer 16 bit with 2Ms/s, Scope per channel, each test point will be sampled and the signal is analyzed by the software with various functions (trigger, waveform signals comparison, envelope etc.) If the system contains 1000 channels, we have 1000 scope channels. The scope won't increase the load at the test points.
- Arbitrary waveform functional generator (AWG) 2 Msteps 16 Bit
- Digital In/Out with standard high voltage pin, 100 kHz, programmable max. 25 V and the fast mode driver max. 31.25 MHz, programmable max. 5 V

Options (see also 2.1.4):
- The on-board programming (OBP) of µC or EEProms or FLASHRoms we carried out via the digital in/out channels. Serial protocols are available and could be customized.
- Boundary scan ATEip partners with Goepel Electronics. The Goepel Galaxy systems provides the BS vector which run's directly on the ATEip EFx digital I/O channel.
- If higher power is required ATEip add's more powerful power supplies to the base system. These systems are fully integrated in the ATEip SEQUENCER©
- Each EFx module own special interface for customer hardware requirements. The system could be adapted easily to additional requirements.

2.2.5 EFx – ATEip SEQUENCER© & National Instruments Teststand

The ATEip NI Teststand adapter provides execution capability of any EFx test program from an NI TestStand test sequence. The EFx test program is created by the EFx sequencer. The over head (e.g. read serial numbers, logging, user-interface, result-handling etc) is organized by TestStand. This interface provide full transfer and exchange of all data. Details are described in the EFx TestStand interface manual.

2.2.6 EFx – ATEip SEQUENCER© Software Application Engineering Station

The EFx Software includes and hardware simulator. All developed test programs can be executed without test system hardware. This is very important for all capable test modes. The software can run on all PC platforms based on intel® i7 6600, 16GBit RAM and 256 SSD. The test program can be debugged off line at the SAE station (SAE - software application engineering / application development)

2.3 EFx System Block Diagram 16 channels

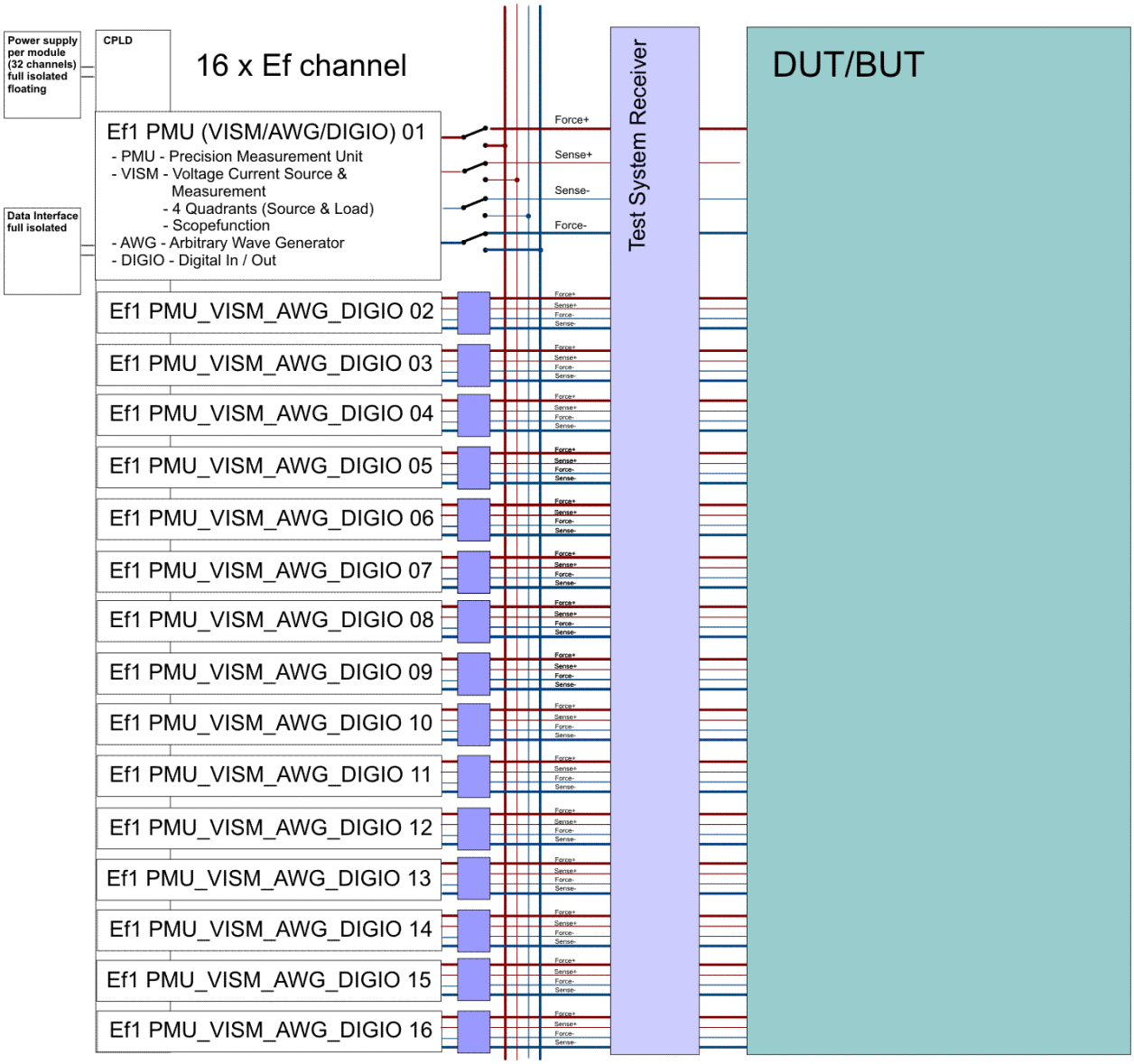


Figure 2.3.1 EFx1 System Module Block Diagram.

In Figure 2.3.1, note that Digital IO Channels may be routed directly to DUT pins via the DUT Performance Board, or these channels may be connected to the DUT via DC Channels via the Switch Matrix. A more detailed diagram of the Switch Matrix is provided by Figure 2.3.2.

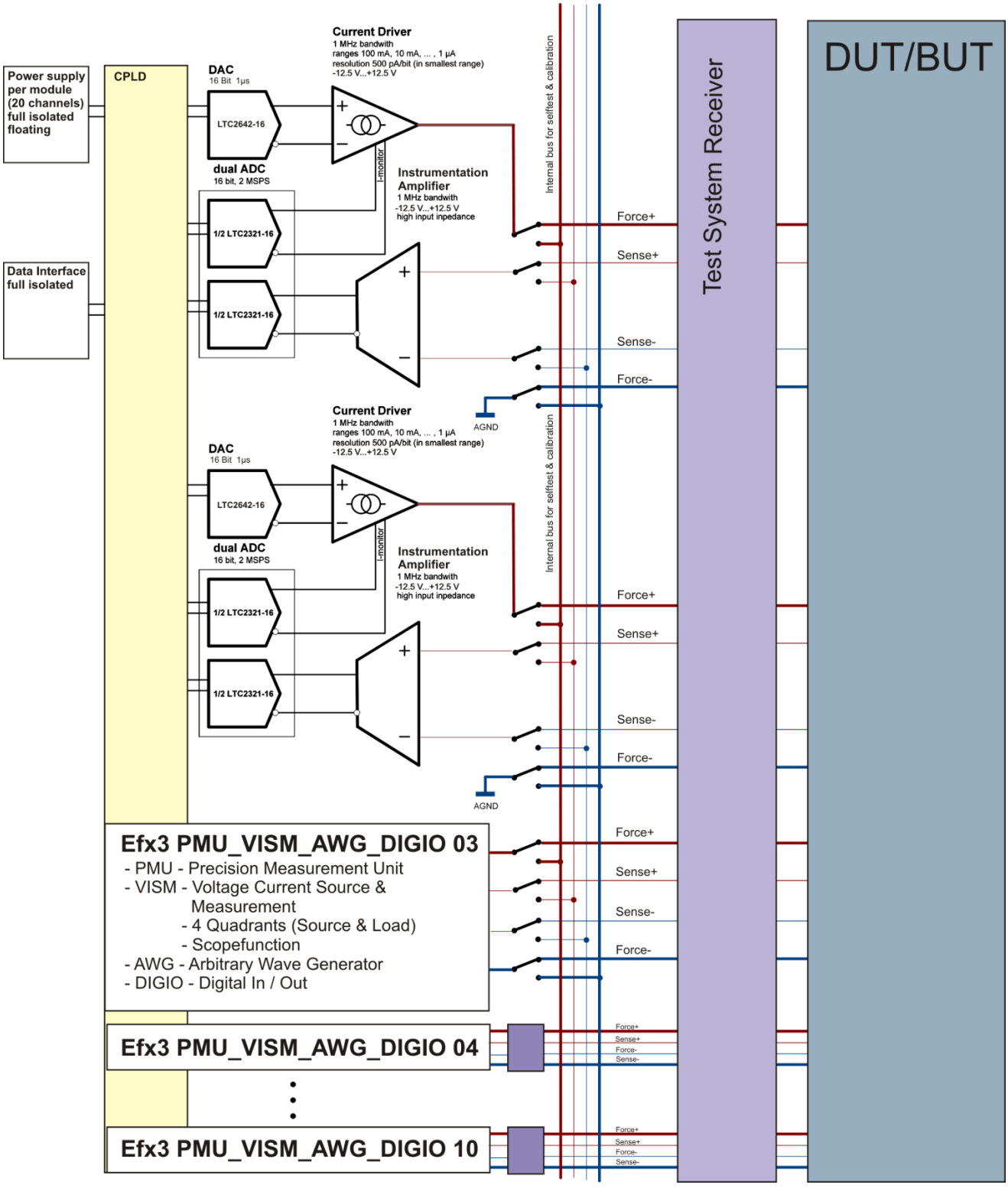


Figure 2.3.2 Test System Module Architecture Block Diagram 19” 4U – 10 channels

2.4 General Product Performance Specifications

Feature	Specification	Details
Number of Test Stations	1	
Architecture	Tester per channel	Dynamic VISM, Digitizer, Scope, AWG per channel
Pin Count		
Hybrid EFx IO Channels 25 V	10 - 3200	10 or 100 channel increments
Hybrid Digital IO Channels 5 V	10 - 3200	10 or 100 channel increments
Parallel Testing	Per test channel	Limited by the no. of test channels
Maximum Frequency		
EFx Channels	1 MHz	Analog multi frequency burst
Digital	31,25 MHz / 5 V	
Digital	100 kHz / 25 V	Unipolar +/- 12,5 V
Pattern Memory Size	4M Vectors	10 k high speed RAM 409.6 kBit per channel DRAM
Data Fail Memory	4M per channel	10 k high speed RAM 409.6 kBit per channel DRAM
Digitizer Memory	64M	
AWG Memory	64M	
Digital IO Channels		
Overall Timing Accuracy	± 5ns	
Timing Edges	Per channel	
Timing Sets	Per channel	
DC Parametric Units		
Hybrid IO Channels	1 per 1 channel	Tester per channel
Utility Power Supplies		
Standard	5 @ 2A each	+5V, -5.2V, +12, ±15

Table 2.4

2.5 System Configuration

Feature	Specification	Details
Test Controller min Processor(s) DRAM Memory Memory / Hard Drive User Interface Removable Storage Display Units	 Intel i5 / 6500U 16 Gbyte 256 GB SSD Keyboard & Mouse USB Stick Standard: 24” LCD Optional: 27” LCD	 CPU with AVX2 @ 2.60 GHz 32 Gbyte ‘touch display’
Interface	USB3 100/1000 Ethernet	
Cables	100/1000 Ethernet Network USB3	
Test Fixtures **Adapter Interface** **Universal Fixture Systems** **Connector Interface**	 Connector interface Augat Pylon Block ODU® MAC Black Line VPC (Viginia Panel) INGUN® HARTING har flex® HARTING har flex®	No. of contacts depend on total tester configuration 40/ 400 contacts per EFx modul 1770 contacts 4608 contacts 4608 contacts PCB based EFx module 40 contacts EFx mux module 100 contacts
Test Fixtures Diagnostic Adapter Calibration Adapter		
Mainframe Unit Power Safety	19” Mainframe AC Power Controller DC Power Supply EMO Switch, Smoke Sensor, Fan Monitor	4 U 19” unit AC 240V, 1 Phase DC 48 V, 25 A Optional
Software Operating System Test System Control Calibration & Diagnostic	MS Windows 7, 8, 10 ATEip SEQUENCER Tester Controller Sets	Linux on request Rev. 1.6 Cal, Diag, Init, etc.
Manual Sets System Hardware ATEip SEQUENCER Software ATEip ELFOX App ATEip Cookbook ATEip EFx TestStand-Interface Hardcopy	 EFx application guide Fast test program generation guide NI TestStand executes EFx hardware	 Standard, German/English Standard, German/English Standard, German/English Standard, German/English Standard, German/English Optional, Hardcopy

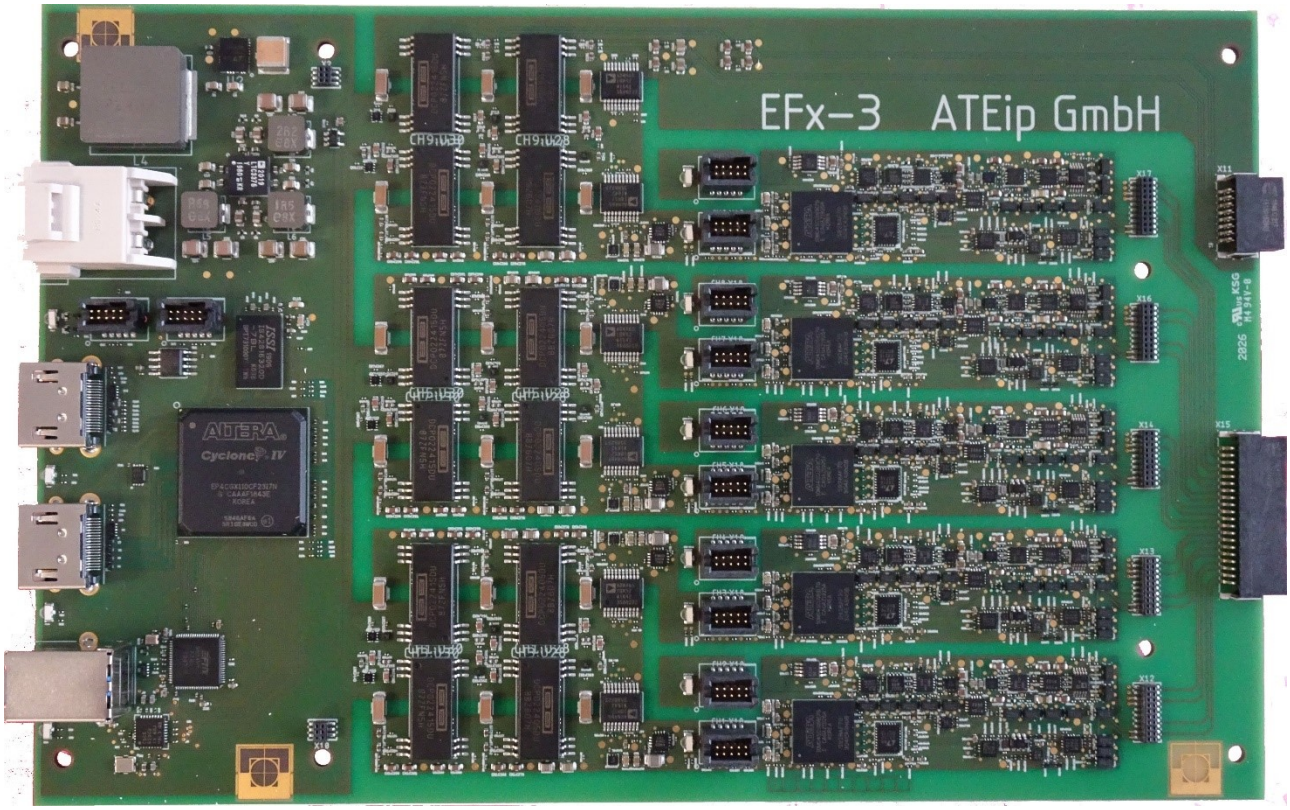
Table 2.5

2.6 Available System Features

Feature	Specification	Details
Available Hardware Options		
External EWS	Engineering Work Station	Offline hardware simulator
Peripherals	Color Printer	
EFx-3 module	No. of modules in the system is unlimited	10 Channel increments
EFx-3 Mux module	1 per EFx-3 module	100 Channel increments
BS Option	JTAG 1149.xx	All DIG I/O Channel increments
PICOSCOPE Option	4 channels	1 GHz / 16 dig Logic 100MHz
Calibration Fixture	CAL1-19001	CAL PB Option
Available Software Options		
Off-line simulator	ATEip SEQUENCER	1, 5, 10 user license options
Adapter Control	Yes	
Handler Control	Yes	
Automation Control	Yes	
MS-Windows 7, 8, 10	Yes	for additional EWS
Manual Sets		
System Hardware	HM1-191002	Paper Manual Set
ATEip SEQUENCER Software	SM1.6-181002	Paper Manual Set
Standards Certifications		
CE Mark : EMC Directive	Available	
Safety Options		
Additional EMO Switch(s)	Up to 2 Maximum	Option
Other Options		
Extender Cable Set	Part Number TBD	
EFx IO PE Carry Case	TB1-EFx1901	
DEMO board	DB1-EFx1901	
Spare Parts Kit		

Table 2.6

3.0 EFx-3 module (Hybrid In/Out Channel Specifications)



Pic. 3.1

EFx-3 module provides 10 individual hybrid in/out channels. Each Channel is a complete test structure and direct channel to allow connection with the DUT/BUT (reference Figures 2.3.1 and 2.3.2).
Each tester channel contains independent 16 Bit concurrent stimuli units for forcing voltage and current with separate independent force and sense channel.
Each stimuli unit contains 16Bit digitizers, which are able to measure concurrently voltage and current.
All signals will be displayed in scope mode on the pc.
Each channel contains an independent digital in / out driver circuit. All channels will be displayed in timing diagram view on pc.
Each channel is floating (potential free) and independent.

3.1 EFx Voltage Source, Current Measurement (VSIM)

Voltage Force Setting

Voltage Setting Range	Voltage Setting Resolution	Setting Range	Setting Accuracy	Available Current Range	Max Current
4V	30.52µV	-2V ~ +2V	±(0.05%+1mV)	1µA ~ 100mA	±100mA
25V	190.73µV	-12.5V ~ +12.5V	±(0.05%+2mV)	1µA ~ 100mA	±100mA

Table 3.1.1

Current Measurement

Current Test Range	Test Resolution	Test Range	Test Accuracy	Max Voltage
10µA	76 pA	-10 µA ~ +10 µA	±(0.2%+40nA+10nA/V)	-12.5V ~ +12.5V
100µA	760 pA	-100µA ~ +100µA	±(0.2%+400nA+100nA/V)	-12.5V ~ +12.5V
1mA	7,6 nA	-1mA ~ +1mA	±(0.2%+4µA+1µA/V)	-12.5V ~ +12.5V
100mA	76 nA	-100mA ~ +100mA	±(0.2%+40µA+10µA/V)	-12.5V ~ +12.5V

Table 3.1.2

3.2 EFx Current Source, Voltage Measurement (ISVM)

Current Force Settings

Current Test Range	Test Resolution	Test Range	Test Accuracy	Max Voltage
10µA	76 pA	-10 µA ~ +10 µA	±(0.2%+40nA+10nA/V)	-12.5V ~ +12.5V
100µA	760 pA	-100µA ~ +100µA	±(0.2%+400nA+100nA/V)	-12.5V ~ +12.5V
1mA	7,6 nA	-1mA ~ +1mA	±(0.2%+4µA+1µA/V)	-12.5V ~ +12.5V
100mA	76 nA	-100mA ~ +100mA	±(0.2%+40µA+10µA/V)	-12.5V ~ +12.5V

Table 3.2.1

Voltage Measurement

Voltage Setting Range	Voltage Setting Resolution	Setting Range	Setting Accuracy	Available Current Range	Max Current
4V	30.52µV	-2V ~ +2V	±(0.05%+1mV)	1µA ~ 100mA	±100mA
25V	190.73µV	-12.5V ~ +12.5V	±(0.05%+2mV)	1µA ~ 100mA	±100mA

Table 3.2.2

3.3 Scope Mode

All analog signals of all channels can be displayed in scope mode on the pc. E.g., if test system configuration contains 1000 channels, the display of 1000 scope channels is concurrently available. All digital channels (fast driver mode and standard high voltage mode) will be displayed in timing diagram view on the pc.

3.4 Waveform Digitizer (DGT)

Feature	Specification	Details
Number of Channels	2 per tester channel	all are running synchronously
Sampling Rate	2 Msps	
DAC Resolution	16-bits	
DC Linearity	0.01% of Full Scale	
Voltage Digitizer		
Mode	Differential Input	
Impedance	10 MΩ	
Bandwidth (-3dB)	250 kHz	
Voltage Range	±30 V differential	selectable differential gain: 1, 10, 100 or 1000
Current Digitizer		
Mode	current measurement	
Bandwidth (-3dB)	250 kHz	
Current Ranges	±100 mA … ±10 µA	4 ranges

Table 3.4

3.5 Arbitrary Waveform Generator (AWG)

Feature	Specification	Details
Number of Channels	1 AWG per tester channel	all are running synchronously
Isolation		
between channels located on same card	100 V	
between channels located on different cards	1 kVrms	1 second, operational isolation
Sampling Rate	2 Msps	
DAC Resolution	16 bits	
DC Linearity	0.01% of Full Scale	
DC Accuracy	< 5 LSB	
DC Offset Voltage	< 100 µV	
Output		
Mode	Voltage Out / Current Out	Selectable
Bandwidth (-3dB)	250 kHz	
Voltage Range	±12.5V / ±2 V	2 ranges
Current Range	±100mA … ±100µA	4 ranges

Table 3.5

3.6 EFx-3 Digital Output

Feature	Specification	Details
Number of Channels	1 per tester channel	all are running synchronously
Isolation		
between channels located on same card	100 V	
between channels located on different cards	1 kVrms	1 second, operational isolation
Bit Rate		
Peak	256 Mbps	
Continuously	16 Mbps	
Output Voltage	0 - 5 V	selectable

Table 3.6

3.7 EFx-3 Digital Input

Feature	Specification	Details
Number of Channels	1 per tester channel	all are running synchronously
Isolation		
between channels located on same card	100 V	
between channels located on different cards	1 kVrms	1 second, operational isolation
Bit Rate		
Peak	256 Mbps	
Continuously	16 Mbps	
Comparator level	0 - 2.5 V	selectable

Table 3.7

3.8 EFx-3 - Digital In / Out Driver Specifications

The EFx system provides per EFx channel digital IO channel. Each channel can perform DC / AC measurements via EFx tester units. Each channel is floating and independent.
The Driver performs in two modes fast driver – and standard mode (high voltage mode).

3.8.1 Fast Mode Driver Mode (5 V; 0 ÷ 5 V)

Feature	Specification	Details
Driver Transition Time		
0V to 5V, 20% to 80 %	5.0 ns ± 1.0 ns	Direct Output
Driver Skew per module	Less than ± 0.5ns	Direct Output
Driver Skew per tester	Less than ± 5ns	Direct Output
Driver Slew rate 5 V	650 V / µs	Direct Output
Minimum Pulse Width		
5V pulse, peak to peak	4 ns	Direct Output (31.25 MHz)
Overshoot	± (Pulse Amplitude x 5% + 50mV)	
Output Pulse Amplitude	0 V to 5V	Direct Output (31.25 MHz)
Output Voltage Resolution	8 Bit	Full range
Output Voltage References	VOt	Per channel
Output Voltage Range VOL VOH	 0 V 0 V to +5 V	 Per channel
Output Voltage Accuracy Output over full range	± (0.5% + 20mV)	
DC Output Current VIo	Source: 50 mA	
Output Impedance	25 pF	
DRE Modes	NRZ / RZ	I/O Switching
DRE Minimum ON Time	4.0ns ± 0.5ns	Driver Enable
DRE Minimum OFF Time	4.0ns ± 0.5ns	Driver Disable

Table 3.8.1

3.8.2 Standard High Voltage Driver Mode (25 V; -12.5 V to +12.5 V)

Feature	Specification	Details
Driver Transition Time		
0V to 25V, 20% to 80 %	0.1 µs ± 10 ns	Direct Output
Driver Skew per module	Less than ± 0.10 ns	Direct Output
Driver Skew per tester	Less than ± 0.1 µs	Direct Output
Driver Slew rate 25V	2.5 V / µs	Direct Output
Minimum Pulse Width		
25V pulse, peak to peak	10 µs	Direct Output (100 kbit)
Overshoot	± (Pulse Amplitude x 5% + 150mV)	
Output Pulse Amplitude	0 V to 25V	Direct Output (100 kbit)
Output Voltage Resolution	16Bit	2 full scale ranges
Output Voltage References	Vit	Per channel (50% Vo)
Output Voltage Range Vo Vo	 -12.5 V to +12.5V -2 V to +2 V	 Vo swing 25 V Vo swing 4 V
Output Voltage Accuracy Output over full range 1 Output over full range 2	16 Bit resolution ± (0.5% + 0,38 mV) ± (0.5% + 61 µV)	
DC Output Current Vo fs 1 Vo fs 2	 Source: 100 mA Source: 100 mA	
Output Impedance	3 pF @ 10 MΩ	
DRE Modes	NRZ / RZ	I/O Switching
DRE Minimum ON Time	0.1 µs ± 10.0ns	Driver Enable
RE Minimum OFF Time	0.1 µs ± 10.0ns	Driver Disable

Table 3.8.2

3.8.3 Digital Pins: Driver Waveforms (Fast Mode)

Feature	Specification	Details
Driver Normal Mode		
Basic Drive	RZ	to 31.25MHz
Basic Drive	NRZ	to 31.25MHz
IO	RZ	to 31.25MHz
IO	NRZ	to 31.25MHz
Driver Double Mode		
Basic Drive	RZ	to 62.5MHz
Basic Drive	NRZ	to 62.5MHz

Table 3.8.3

3.8.4 Comparator Specifications (Fast Mode)

Feature	Specification	Details
Terminator / Load		
High Impedance (Hi-Z)	10MΩ or greater	
Transition Time		
0V to 3V, 20% to 80%	4.0ns ± 1.0ns	
Input Range	0 V to 5.0 V	
Compare Voltage Resolution	5mV	
Output Voltage References	VOT	per channel / 50%of VOH
Compare Voltage Range		
VOH	0 V to + 5 V	
VOL	0 V to +5 V	
Output Voltage Accuracy	± (0.5% + 20mV)	± 1LSB
Leakage Current		
0V to 5.0V	±70nA	
Outside 0-5V Range	±1µA	
Input Capacitance	< 25pF	Direct Output Path

Table 3.8.4

3.8.5 Comparator Specifications (High Voltage Standard Mode)

Feature	Specification	Details
Terminator / Load **High Impedance (Hi-Z)**	10MΩ or greater	
Transition Time 0V to 15V, 20% to 80%	6 µs	
Input Range	-25.0V to 25.0V	
Compare Voltage Resolution	50mV	
Output Voltage References	VOT	One Trigger voltage per channel
Compare Voltage Range VOH VOL	 -12.5V to +12.5V -12.5V to +12.5V	
Output Voltage Accuracy	± (0.5% + 20mV)	
Leakage Current 0V to 25.0V Outside 0-25V Range	 ±700nA ±1µA	
Input Capacitance	< 3pF	Direct Output Path

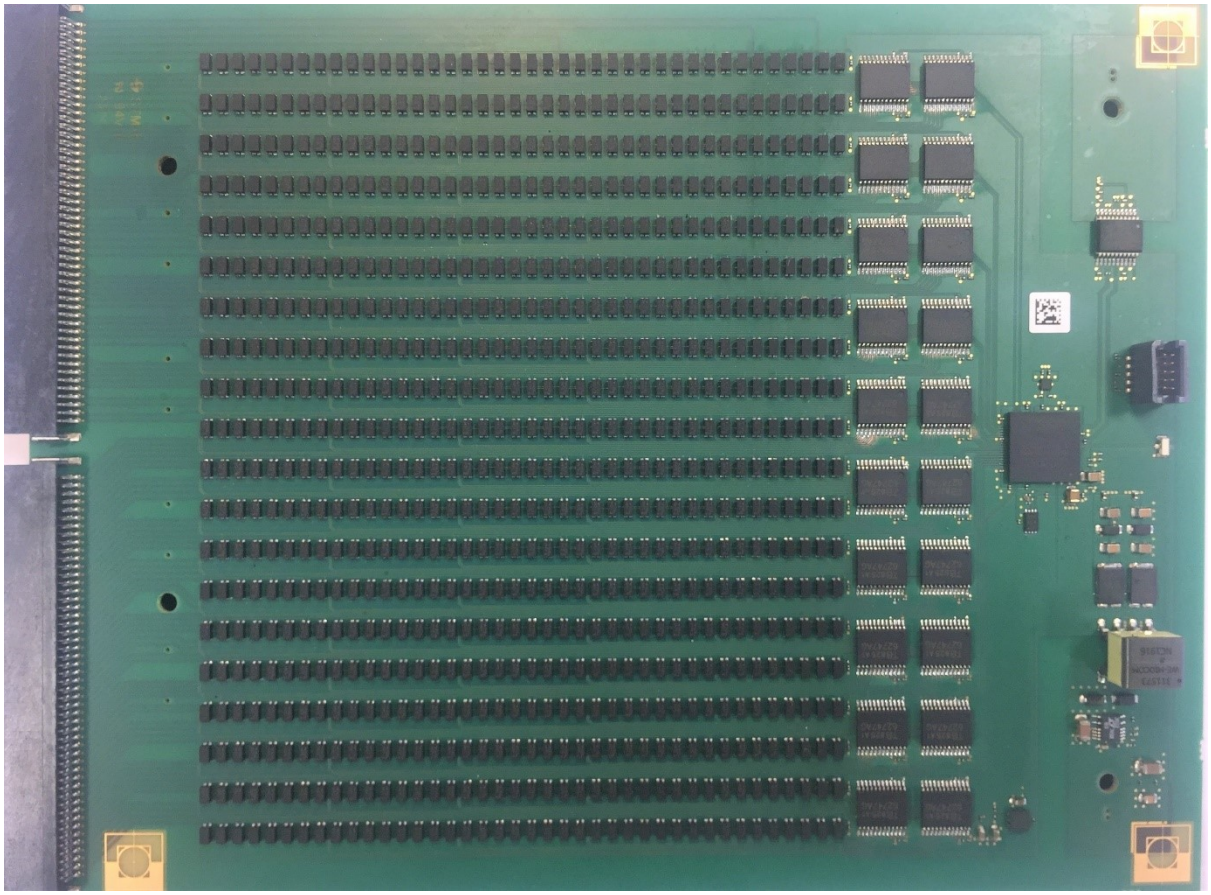
Table 3.8.5

3.8.6 Over/Undershoot, Slew Rate, Alarms

Characteristic	Specification	Details
Over / Undershoot 8µA ~ 100mA Ranges	≤ 5% of program voltage or 0.3V	Whichever is greater
Input Impedance	10MΩ or greater	
Programmable Slew Rate **Setting Range** **Setting Resolution**	 1V / 25µS to 1V / 25ms 6.25µs	 See Note 3.4.1
Alarm Functions Current clamp operation detection Abnormal voltage detection by Kelvin bridge Guard current abnormality detection Oscillation abnormality detection	Not implemented yet	

Table 3.8.6

3.9 EFx-3 Mux Multiplexer module (Specifications)



Pic. 3.9

EFx-3 Mux Multiplexer module provides 100 individual hybrid in/out channels. Each Input Channel is multiplexed to 10 output channels. The output connectors support 400 contacts means 10 times the complete EFx-3 test structure to allow connection with the DUT/BUT (reference Figures 2.3.1 and 2.3.2).
The EFx-3 plus EFx-3Mux module supports 100 channels, means 4 contacts per channel.
The interface connectors are 4 x Harting Har-flex 515 100 6601_000 (100 contacts)

The module is connected as a piggy pack board on top of the EFx-3 module, connected by the expansion ports of the EFx-3 module.

The performance data of the EFx-3 module is not changed and the specification is kept.

4.0 EFx-3 HVB (High Voltage Booster) Option Specifications

(R&D target specification)

The EFx-3HVB provides up to 5 high voltage (125 /250 V) standard channels, which are available via customized piggy pack module over a breaker relay directly connected to the system interface.

4.1 EFx-3HVB: Voltage Source, Current Measurement (VSIM)

Voltage Force Setting

Voltage Setting Range	Voltage Setting Resolution	Setting Range	Setting Accuracy	Available Current Range	Max Current
4 V	30.52 µV	-2V ~ +2V	±(0.05%+1mV)	1µA ~ 100mA	±100mA
25 V	190.73 µV	-12.5V ~ +12.5V	±(0.05%+2mV)	1µA ~ 100mA	±100mA
75 V	572.2 µV	-37.5 ~ +37.5 V	±(0.05%+5mV)	1µA ~ 100mA	±100mA
100 V	763 µV	-50V ~ +50V	±(0.05%+8mV)	1µA ~ 100mA	±100mA
150 V	1.14 mV	-75V ~ +75V	±(0.05%+10mV)	1µA ~ 100mA	±100mA
250 V	1.91 mV	-125V ~ +125V	±(0.05%+20mV)	1µA ~ 100mA	±100mA

Table 4.1.1

Current Measurement

Current Test Range	Test Resolution	Test Range	Test Accuracy	Max Voltage
1µA	15.3 pA	-1µA ~ +1µA	±(0.25%+10nA+1nA/V)	-125V ~ +125V
10µA	153 pA	-10µA ~ +10µA	±(0.1%+40nA+5nA/V)	-125V ~ +125V
100µA	1.53 nA	-100µA ~ +100µA	±(0.1%+400nA+50nA/V)	-125V ~ +125V
1mA	15.3 nA	-1mA ~ +1mA	±(0.1%+4µA+500nA/V)	-125V ~ +125V
10mA	153 nA	-10mA ~ +10mA	±(0.25%+40µA+5µA/V)	-125V ~ +125V
100mA	1.53 µA	-100mA ~ +100mA ±200mA ~ ±300mA ±300mA ~ ±800mA	±(0.25%+400µA+50µA/V) ±(0.25%+400µA+50µA/V) ±(1.0%+400µA+50µA/V)	-125V ~ +125V -30V ~ +30V -30V ~ +30V

Table 4.1.2

4.2 EFx-3HVB: Current Source, Voltage Measurement (ISVM)

Current Force Settings

Current Test Range	Test Resolution	Test Range	Test Accuracy	Max Voltage
1µA	15.3 pA	-1µA ~ +1µA	±(0.25%+10nA+1nA/V)	-125V ~ +125V
10µA	153 pA	-10µA ~ +10µA	±(0.1%+40nA+5nA/V)	-125V ~ +125V
100µA	1.53 nA	-100µA ~ +100µA	±(0.1%+400nA+50nA/V)	-125V ~ +125V
1mA	15.3 nA	-1mA ~ +1mA	±(0.1%+4µA+500nA/V)	-125V ~ +125V
10mA	153 nA	-10mA ~ +10mA	±(0.25%+40µA+5µA/V)	-125V ~ +125V
100mA	1.53 µA	-100mA ~ +100mA ±200mA ~ ±300mA ±300mA ~ ±800mA	±(0.25%+400µA+50µA/V) ±(0.25%+400µA+50µA/V) ±(1.0%+400µA+50µA/V)	-125V ~ +125V -30V ~ +30V -30V ~ +30V

Table 4.2.1

Voltage Measurement

Voltage Test Range	Voltage Test Resolution	Test Range	Test Accuracy	Available Current Range	Max Current
4 V	30.52 µV	-2V ~ +2V	±(0.05%+1mV)	1µA ~ 100mA	±100mA
25 V	190.73 µV	-12.5V ~ +12.5V	±(0.05%+2mV)	1µA ~ 100mA	±100mA
75 V	572.2 µV	-37.5 ~ +37.5 V	±(0.05%+5mV)	1µA ~ 100mA	±100mA
100 V	763 µV	-50V ~ +50V	±(0.05%+8mV)	1µA ~ 100mA	±100mA
150 V	1.14 mV	-75V ~ +75V	±(0.05%+10mV)	1µA ~ 100mA	±100mA
250 V	1.91 mV	-125V ~ +125V	±(0.05%+20mV)	1µA ~ 100mA	±100mA

Table 4.2.2

4.3 EFx-3HV DC : Voltage Measurement Mode (MVM)

Voltage Measurement

Voltage Test Range	Voltage Test Resolution	Test Range	Test Accuracy
4 V	30.52 µV	-2V ~ +2V	±(0.05%+1mV)
25 V	190.73 µV	-12.5V ~ +12.5V	±(0.05%+2mV)
75 V	572.2 µV	-37.5 ~ +37.5 V	±(0.05%+5mV)
100 V	763 µV	-50V ~ +50V	±(0.05%+8mV)
150 V	1.14 mV	-75V ~ +75V	±(0.05%+10mV)
250 V	1.91 mV	-125V ~ +125V	±(0.05%+20mV)

Table 4.3

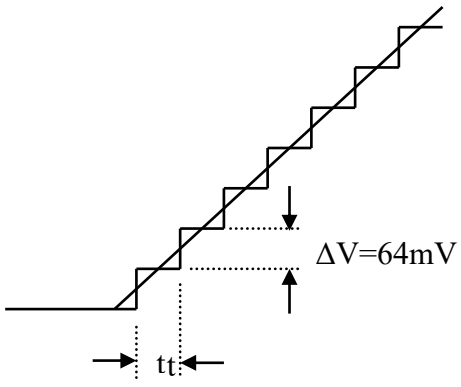
4.4 EFx-3HV DC: Over/Undershoot, Slew Rate, Features, Alarms

Characteristic	Specification	Details
Over / Undershoot 1µA to 100mA Ranges	≤ 5% of program voltage or 0.3V	Target value, not finally specified yet
Input Impedance	10MΩ or greater	
Programmable Slew Rate Setting Range Setting Resolution	 1V / 250µs to 1V / 25ms 6.25µs	 See Note
Mean Current Measurement **Sampling Speed** **Measurement Period**	Available 100µs Fixed 10 Seconds Maximum	
Measurement Timing	Start and Test timing can be set	
Parallel Measurement	All HVDC Channels can be measured in parallel	
Alarm Functions Current clamp operation detection Abnormal voltage detection by Kelvin bridge Guard current abnormality detection Oscillation abnormality detection		Target function

Table 4.4

Notes:

Slew rate is adjusted in order to determine the "t" point as shown in the figure below. The voltage step ΔV is fixed at 64mV.



5.0 Optional Functional Test, Hardware Specifications

5.1 Digital SCOPE (PICOSCOPE®)

5.1.1 General features :

- Full tester integrated high speed scope module
- Scalable up to 4 scope channels
- Sample rate 1 GS/s or 10 GS/s
- Scalable resolution 8 Bit to 16 Bit
- 200 MHz bandwidth,
- Switchable to each test system channel via shielded cross matrix
- Logic analyser 16 channels 100MHz
- Function generator 1 MS or 20 MS fix or arbitrary
- Spectrum analyser function

Pic. 5.1.1

5.1.2 Specification

Pos.	Feature	type 3204MSO	type 3406MSO	type 5242B
1	**Analog (vertical)**			
2	Analog input channels	2	4	2
3	Input type	Single ended, BNC	Single ended, BNC	Single ended, BNC
4	Bandwidth (-3dB)	50 MHz	200 MHz	200 MHz
5	Rising edge (calc.)	7,0 ns	1,75 ns	1.75ns
6	Bandwidth limiter	20 MHz, selectable	20 MHz, selectable	20 MHz, selectable
7	Vertical resolution	8 Bit	8 Bit	scalable 8 to 16 Bit
8	Input voltage range	± 20 mV to ± 20 V	± 20 mV to ± 20 V	± 20 mV to ± 20 V
9	Full scale ranges	10	10	10
10	Input coupling	AC/DC	AC/DC	AC/DC
11	Input impedance	1 MΩ // 14 pF	1 MΩ // 14 pF	
12	DC-precision	±3 % f.s.range, ±200 µV		
13	Analog Offset	±250 mV (Range 20 mV, 50 mV, 100 mV and 200 mV)		
		±2,5 V Range 500 mV, 1 V, 2 V)		
		±20 V (Range 5 V, 10 V, 20 V)		
14	Over voltage protection	±100 V (DC + AC peak)		
15	Skew between channels	2 ns, typical		
16	**Digital (only MSO)-vertical**			not available
17	Input Channel	16 channel (2 Ports with 8 Channel each)		-
18	Max. input frequency	100 MHz (200 MB/s)		-
19	Min. pulse width	5 ns		-
20	Input impedance	200 kΩ ±2 % 11 // 8 pF ±2 pF		-
21	Input dynamic range	±20 V		-
22	Triggr range	±5 V		-
23	Trigger groups	2 independent groups Port 0: D0 to D7, Port 1: D8 to D15		-
24	Trigger level selection	TTL, CMOS, ECL, PECL, programmable		-
25	**Horizontal**			
26	Max. sample rate (real time) * 1 digital port has 8 channels	1 GS/s: 1 analog channel in use		
		500 MS/s: up to 2 analog channels or digital Ports* in use		
		250 MS/s: up to 4 analog channels or digital Ports* in use		
		125 MS/s: more than 4 analog channels or digital Ports* in use		

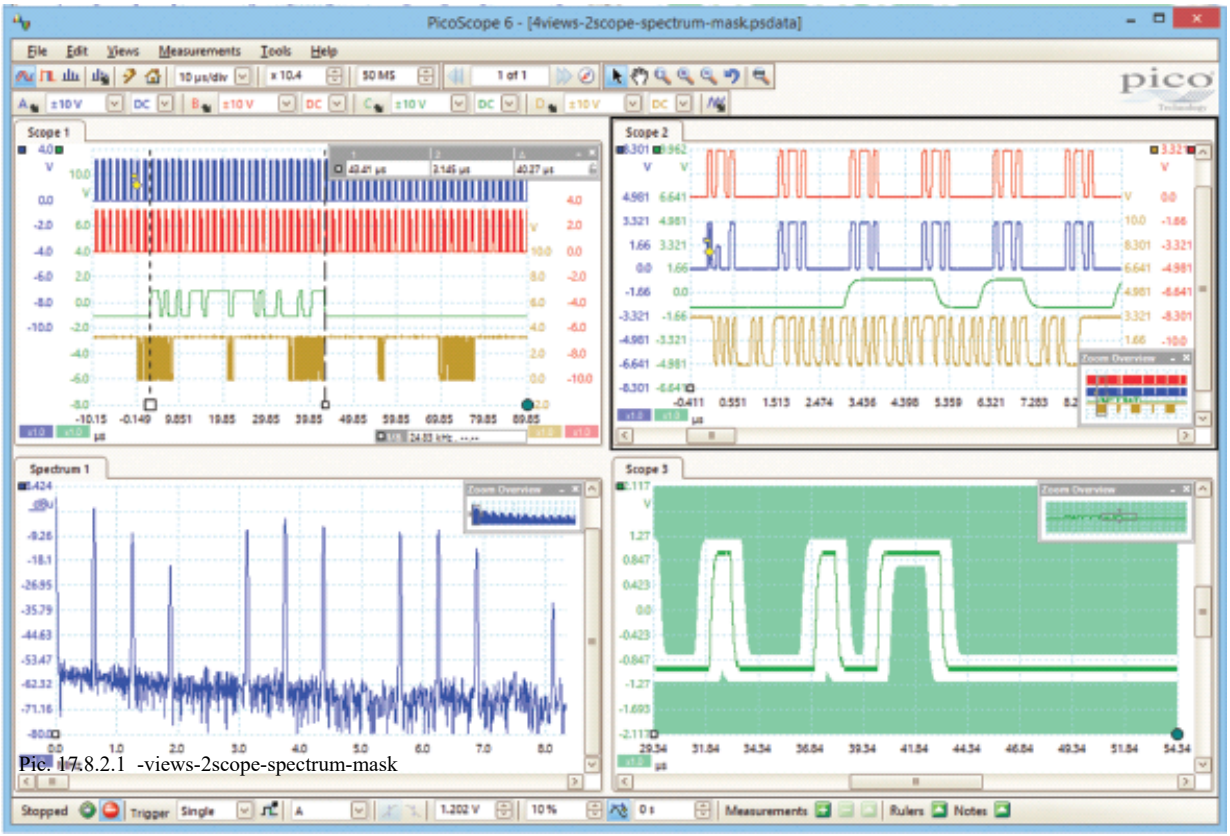
Table 5.1.2.1

Pos.	Feature	type 3204MSO	type 3406MSO	type 5242B
27	Max. real time sample rate (ETS) (repeatable signals)	2,5 GS/s	10 GS/s	10 GS/s
28	Max. sample rate	10 MS/s in PicoScope-Software, splitted between active channels (depending on PC config)		
29	Streaming continous	125 MS/s by using the shipped SDK, devided between the active channels (depending on PC-config)		
30	Max. detection rate	100.000 wafeforms per second (depending on PC-config)		
31	Buffer memory	64 MS	512 MS	512 MS
32	**Function generator**			
33	Standard-output signals	Sine-, rectangle and triangle wafeforms, DC, rising-, falling-, Sine-, Gaussche and halfsine-wafeforms.		
33	Radom signals	White noise, amplitude and offset selectable within the output voltage range.Pseudo-random binary sequences (PRBS), upper and lower value selectable within the output voltage range. Programable bitrate up to 1 MB/s.		
34	Standard-signal frequency	DC bis 1 MHz		20 MHz
35	Output voltage	±2 V		
36	**Arbitrary function generator**			
37	Frequency	20 MHz		200 MS/s
38	Buffer size	32 kS		48 kS
39	Resolution	12 Bit		14 Bit
40	Bandwidth	> 1 MHz		20 MHz
41	Rising time (10 % to 90 %)	< 120 ns		< 10 ns
42	**Spectrum analyzer**			
43	Frequency range	DC up to the full band width od the scope		
44	Display modes	Intensity-, averaging-, peak- level storage at memory		
45	Y-Axis	Logarithmic (dbV, dBu, dBm, customized dB) or linear (Volt)		
46	X-Axis	Linear or logarithmic		
47	Window functions	Rectangle, Gauss, triangle, Blackman, Blackman-Harris, Hamming, Hann, flat		
48	FFT-points	programable from 128 up to 1 Million with exponent 2		
49	**Reach Channels**			
50	Functions	−x, x+y, x−y, x*y, x/y, x^y, sqrt, exp, ln, log, abs, norm, sign, sin, cos, tan, arcsin,		
		arccos, arctan, sinh, cosh, tanh, Frequency, Derivative, Integral, Minimum, Maximum, Middle, Peak, Delay, High Pass, low Pass, Bandpass, Bandstopp		
51	Operands	All analog and digital input channels, Reference wafeforms, time, constant values, π		
52	**Automatic measurments (only analog channels)**			
53	Scope mode	AC eff, true eff, cycle time, DC average, pulse rate, falling edge rate, falling edge time, frequency, high pulse width, low pulse width, maximum, minimum, peak-peak, rising edge time, slew		
54	Spectral mode	Frequency at tip, amplitude at tip, average amplitude at tip, total Power consumtion, total distorsions factor in %, total distorsions factor in dB, total distorsions factor plus noise, SFDR, SINAD, SNR, IMD		

Table 5.1.2.2

Pos.	Feature	type 3204MSO	type 3406MSO	type 5242B
55	Statistic	Minimum, Maximum, Middle,Standard Deviation		
56	**Serial Descryption**			
57	Protocol	CAN, FlexRay, I2C, I2S, LIN, SPI, UART/RS-232, USB		
58	**Mask Boundary Testing**			
59	Statistics	Error Correcting,Number of Errors,Total		
60				
61	**Display**			
62	Interpolation	Linear or sin(x)/x		
63	Persistence Modes	Digital Color, analog Intensity, fast, expanded		

Table 5.1.2.3



Pic. 17.8.2.1 -views-2scope-spectrum-mask

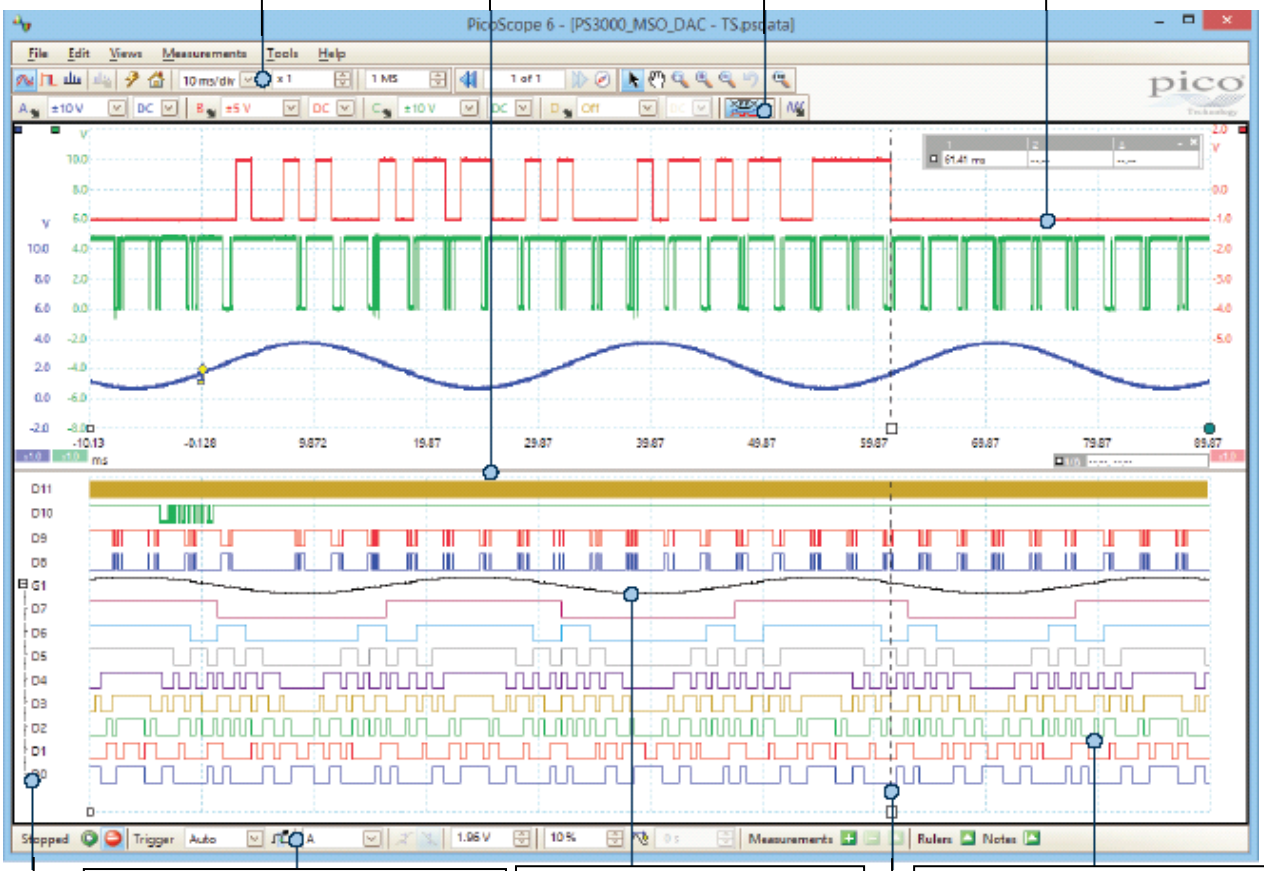
Pict. 5.1.3

Split-screen display: PicoScope can display both analog and digital signals at the same time. The split-screen display can be adjusted to give more / less to the analog waveforms.

Analog waveforms: View analog waveforms time correlated with digital inputs.

Oscilloscope controls: PicoScope's full analog-domain controls, including zoom, filtering, and function generator, are all available in MSO digital signal mode.

Digital channels button: Set up and display digital inputs. View analog and digital signals on the same time base.



Advanced triggers: Additional Digital and Logic trigger options are available for digital channels

Show by level: Group bits into fields and then display as an analog level.

Display format: Display selected bits individually or as groups in numerical or ASCII format.

Rename: The digital channels and groups can be renamed. Groups can be expanded or collapsed in the digital view.

Rulers: Drawn across both analog and digital panes so signal timings can be compared.

Pict. 5.1.4

6.0 DUT Interface Specifications

6.1 Fixed Utility Power Supply Options Specifications

Voltage Supply	Fixed Voltage	Maximum Current
FUPS1 24 V	+24 V ±5%	1.5 A
FUPS4 24 V	+24 V ±5%	1.5 A
FUPS2 12 V	+12 V ±5%	1.5 A
FUPS5 12 V	+12 V ±5%	1.5 A
FUPS3 5 V	+5 V ±5%	5 A
FUPS6 5 V	+5 V ±5%	5 A

Table 6.1

6.2 Programmable Utility Power Supply Options Specifications

Voltage Supply	Programmable Voltage	Maximum Current
PUPS1 0…32 V	+0 ÷ 32 V ±5%	3 A
PUPS2 0…32 V	+0 ÷ 32 V ±5%	3 A
PUPS3 0…32 V	+0 ÷ 32 V ±5%	3 A
PUPS4 0…32 V	+0 ÷ 32 V ±5%	3 A
PUPS5 0…60 V	+0 ÷ 60 V ±5%	10 A
PUPS6 0…60 V	+0 ÷ 60 V ±5%	10 A

Table 6.2

6.3 DUT Adaptor Control Signal Specifications

Feature	Specification	Details
RFID Tag	256 Max	DUT Adaptor ID Revision ID Customized #1 - #100 parameter
Bare-Code	256 Max	DUT Adaptor ID Revision ID Customized #1 - #100 parameter
Control Words		
Number of bits	Port 8	Wired on adaptor
Allowable Current	Active link	

Table 6.3

7.0 Adaptor Fixture & Performance Board (PB) Specs

Information provided below is based on the EFx interface

Feature	Specification	Details
Adaptor Heat Resistance	-30° ~ +125°	
Adaptor Mounting Sensor	Available	Verifies Fixture if mounted correctly; depend on the fixture system
PB / Bed of nail FIXTURE		PB/FIXTURE
PCB Board/FIXTURE	1600 / 3200	Layout – no wire wrap fixture
PCB Board including utilities		Add on hardware layout
Fixture	1600	Wire Wrap
PB/Utility revision sensing		PB/Utility revisions can be sensed with online function
PB / Bed of nail and test program	RFID / EEPROM	Max revision number
Fixture Revision	RFID / EEPROM	Max revision number
TP Revision	RFID / EEPROM	Max revision number
Regular wiring length on PB	5 ns	

Table 7.0

7.1 Fixture Interface Pylon Block

1600TP – Kelvin test channels

7.2 Fixture Interface ODU Block

4400 TP – Kelvin test channels

7.3 Fixture Interface VPC Block

Customized Virginia Panel (VPC) configuration

7.4 Fixture Interface In-Line Connector

Based on configuring unlimited number of tester channels, the cables to the In-Line station are following the standard of the In-Line automation vendor.

7.5 Wireless Kelvin Fixture based on INGUN

8.0 System CPU and Software

8.1 System CPU Architecture

The EFx test system uses the ATEip SEQUENCER Operating System. The OS runs on the MS-Windows PC. An overview of the structure provided via Figure 8.1.

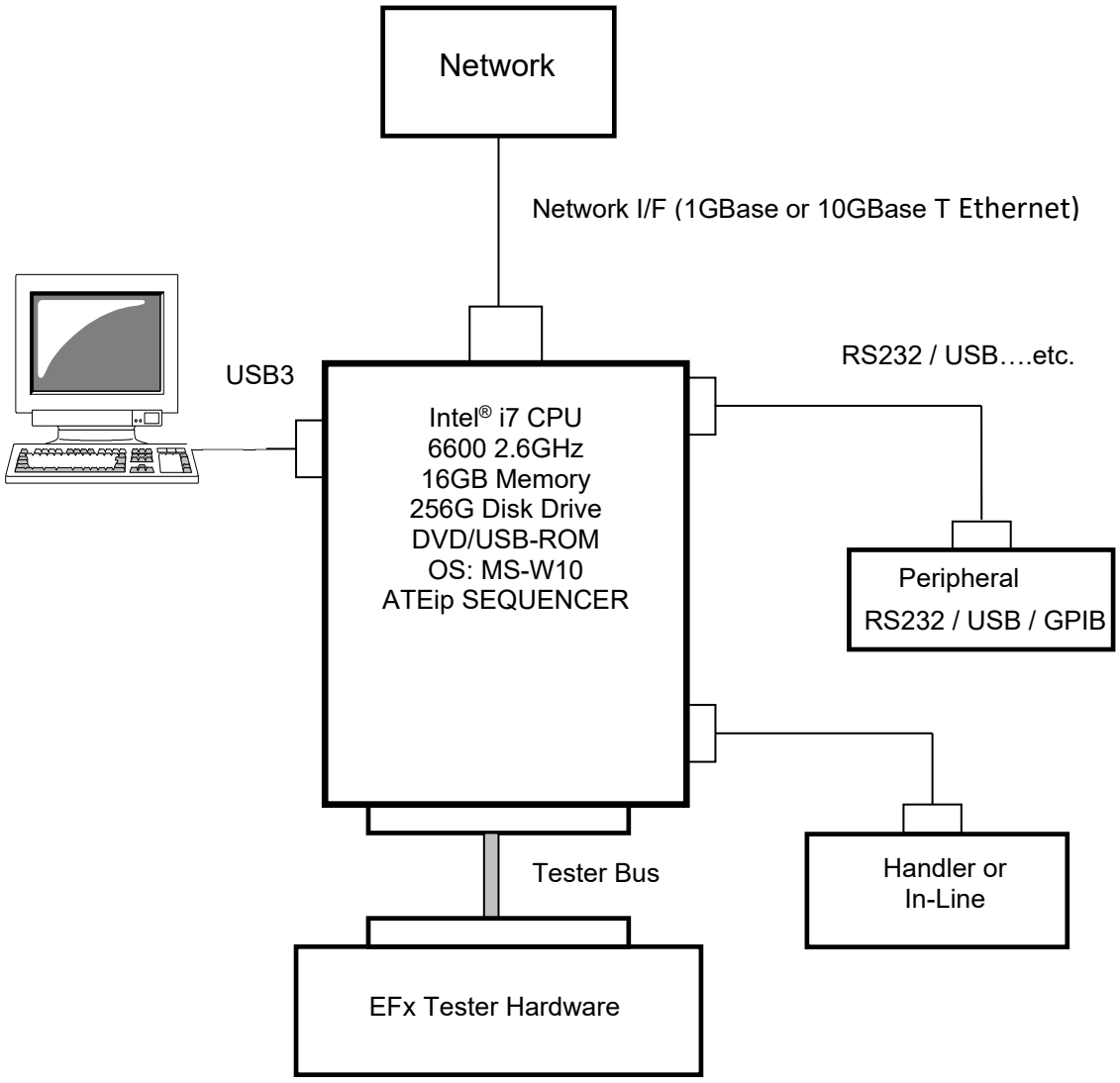


Figure 8.1 Overview of EFx1 PC Architecture.

8.2 ATEip SEQUENCER Operating Software

ATEip SEQUENCER software provides an environment that executes user generated test programs using the EFx system hardware, or via VSIM, a test system virtual simulator.
VSIM allows offline test program development and debug.

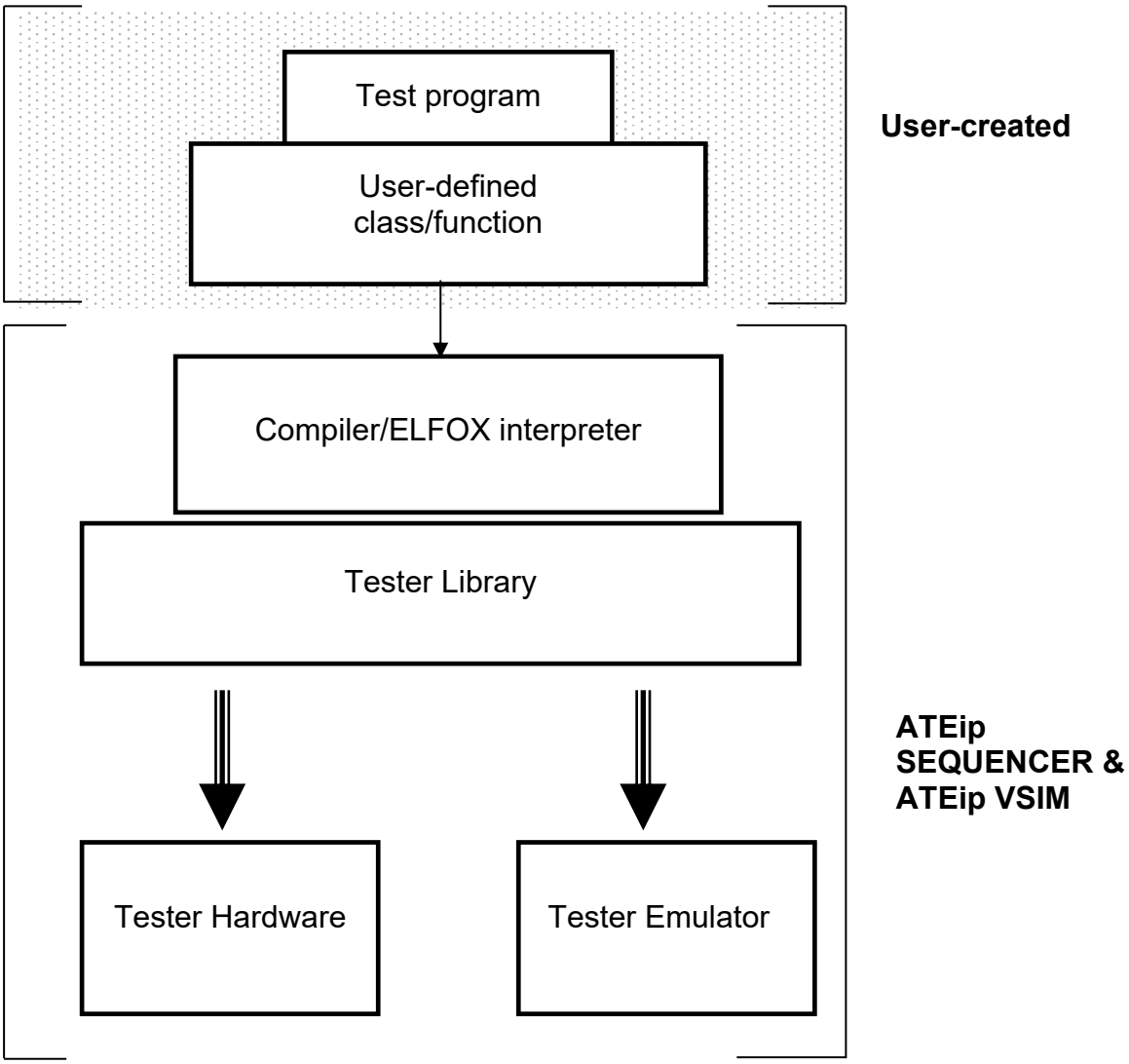


Figure 8.2 ATEip SEQUENCER and ATEip VSIM operating software block diagram.

8.3 ATEip SEQUENCER Operator Interface Software

Standard ATEip SEQUENCER operator interface

8.4 ATEip SEQUENCER Database Interface Software

Standard ATEip SEQUENCER data transfer and data base interface

9.0 System Installation Specifications

9.1 System Cabinet Sizes

9.1.1 EFx-2/3- 1600 Desktop System

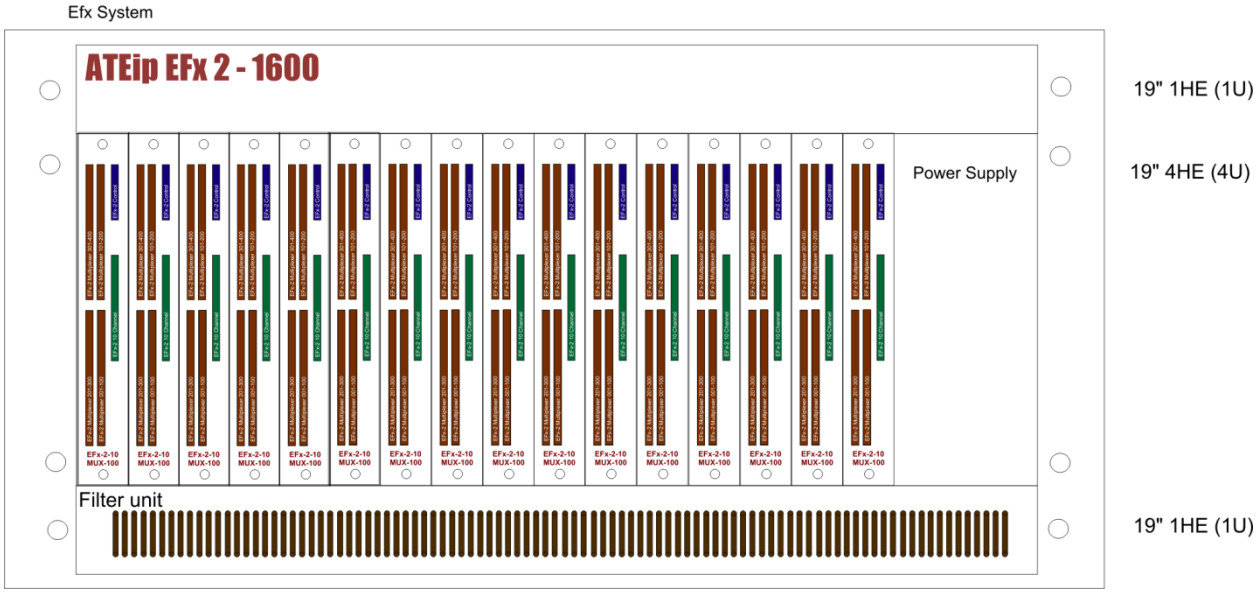


Figure 9.1.1 EFx-2/3-1600 Test System

Unit	Size, Metric in meters, W x D x H	Size, US in inches, W x D x H
Test Station	0.60m x 0.450m x 0.30m	23.6 x 18 x 12
Recommended Work Area	Depend on fixture system	Depend on fixture system

W = Width (Across front of unit) **D =** Depth (Front to Back of unit) **H =** Height of unit

Table 9.1.1

9.1.2 EFx-2- Fly Expansion – Flying Prober Enhancement

Figure 9.1.2 EFx-3-FlyExpansion Test System

Unit	Size, Metric in meters, W x D x H	Size, US in inches, W x D x H
Test Modul (1U 19" slot)	0.483m x 0.450m x 0.045m	19 x 18 x 0.175
Recommended Work Area	Depend on cabling	Depend on cabling
Module slot (integrated in 19" 1U module)	Prepared for 2 EFx module 1 Power supply	

W = Width (Across front of unit) **D =** Depth (Front to Back of unit) **H =** Height of unit

Table 9.1.2

9.1.3 EFx-2/3- MUX100 EFx-3 Modul inclusive Multiplexer 100

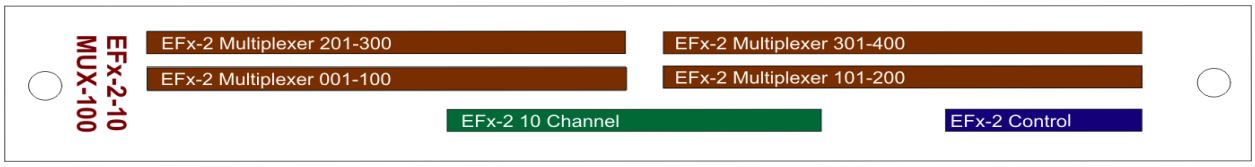


Figure 9.1.3 EFx-2/3 Module with Mux100

Unit	Size, Metric in meters, W x D x H	Size, US in inches, W x D x H
EFx module size incl. front panel	0.2m x 0.25m x 0.02	8 x 0.985 x 0.08

W = Width (Across front of unit) **D =** Depth (Front to Back of unit) **H =** Height of unit

Table 9.1.3

9.1.4 EFx-2/3- 3200 System

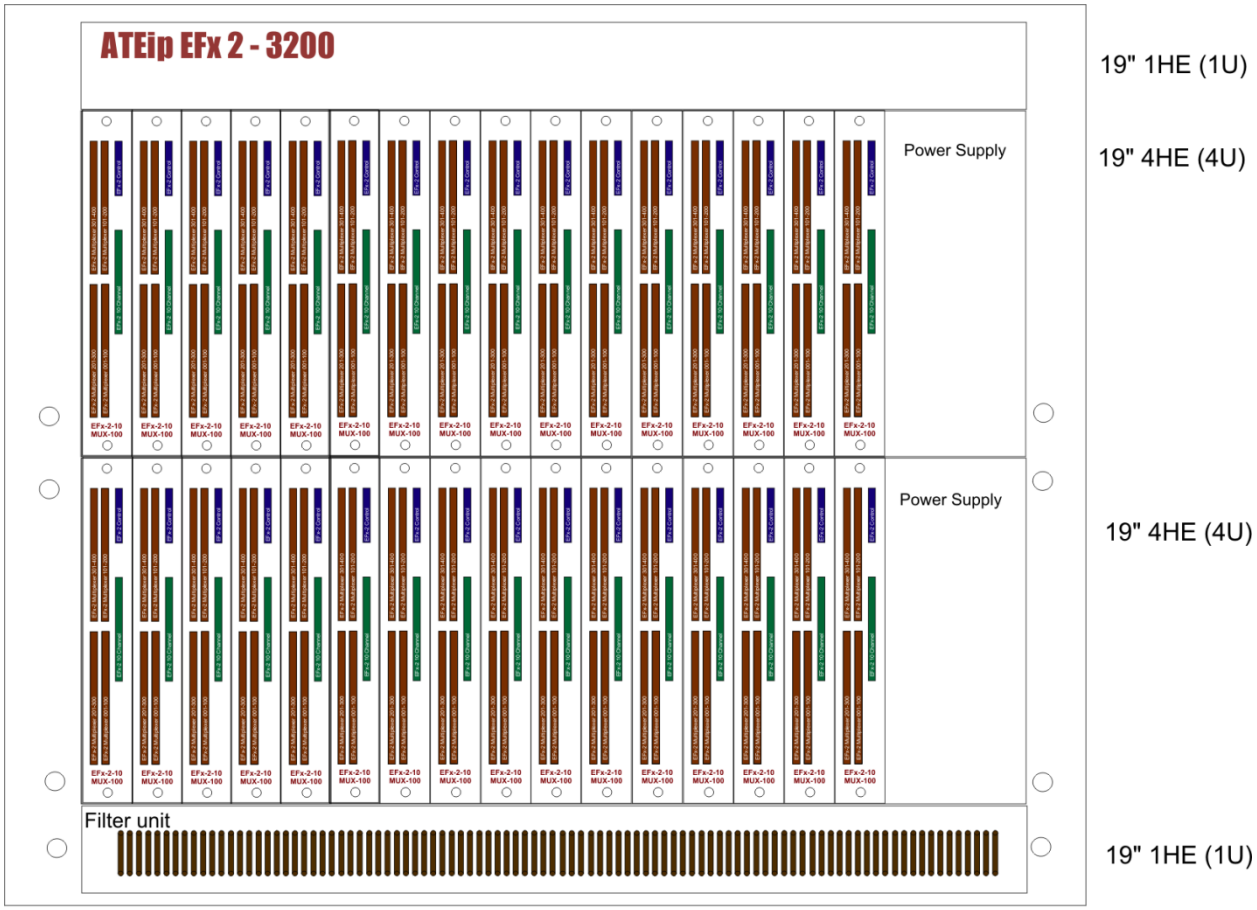


Figure 9.1.4 EFx-2/3-3200 Test System

Unit	Size, Metric in meters, W x D x H	Size, US in inches, W x D x H
Test Station	0.60m x 0.450m x 0.5m	23.6 x 18 x 20
Recommended Work Area	Depend on fixture system	

W = Width (Across front of unit) **D =** Depth (Front to Back of unit) **H =** Height of unit

Table 9.1.4

9.1.5 19” Rack EFx-2/3- 1600 System inclusive Extensions

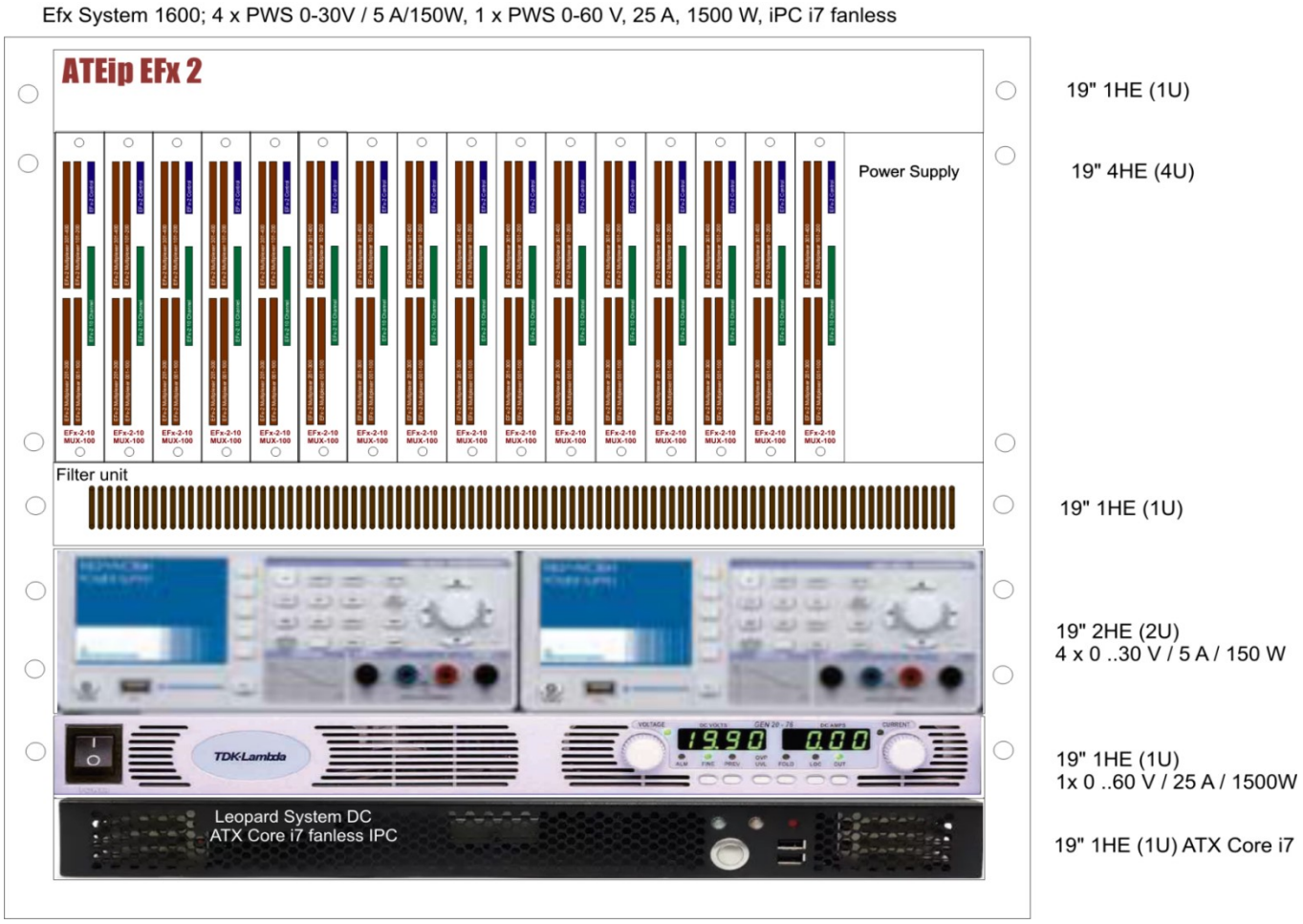


Figure 9.1.5 EFx-2/3-1600 Test System + Extensions (Example)

Unit	Size, Metric in meters, W x D x H	Size, US in inches, W x D x H
Test Station	0.60m x 0.450m x 0.5m	23.6 x 18 x 20
Recommended Work Area	Depend on the fixture system	

W = Width (Across front of unit) **D =** Depth (Front to Back of unit) **H =** Height of unit

Table 9.1.5

9.2 EFx 19” rack mount version 10 modules

Figure 9.2 19” rack EFx-2/3 100/ 1000 Test System (Harting connector interface)

9.3 EFx 19” rack table version

Figure 9.3 Hera Desk with 19” rack EFx-3 100 / 1000 Test System + VPC Interface (Example)

9.3 In-Line solution EFx-2/3- System (example)

Figure 9.2 Kabtec 1000i for EFx-2/3-3200 Test System + Extensions (Example)

9.2.1 Kabtec-1000i/2000i In-Line Handling Systems Specifications

Parameter	KT1000i	KT2000i
Exchange kit	Ingun compatible Ingun ATS MA2112	Ingun compatible Ingun ATS MA2112
Contacting	Multi-stage from below, possible on both sides by Handover epins	Multi-stage Double
Tests	EFx / FKT	EFx / FKT
Transport	Conveyor	Conveyor
Exchange time	< 1min	< 1min
BUT size (mm)	285 x 240	500 x 450
Contact force (N)	max. 2000	max. 9.000
Number of TP	standard 1200	4.420 (expandable to max. 4.800)
Transport level hight	950 +/- 50	950 +/- 50
Handling time (s)	3	5
Handling time SMEMA	5	7
Min. Testpad diameter	0.8	0.4
Dimensions WxDxH (mm)	600 x 970 x 1670	900 x 1.200 x 1.670
HMI	12" touch panel	12" touch panel
compenent high top/bot	max 50/50	max 50/50
power	230 V / 50Hz	230 V / 50Hz
Pressured Air	6 bar	6 bar
Weight (kg)	250	450

W = Width (Across front of unit) **D =** Depth (Front to Back of unit) **H =** Height of unit

Table 9.2.1

10.0 System Power Requirements

Power	Requirement	
Electrical Power - Desktop System EFx-3-1600 - EFx Fly Expansion - EFx Module - System EFx-3-3200	 240 V x 2 A 1 phase 240 V x 1 A 1 phase DC 48 V x 1 A 240 V / 5 A 1 phase	 or Required DC 48 V / 1 A Required DC 48 V / 1 A
Voltage Range	240V +/- 10% 110V to 240V	On request
AC Power Stability	50Hz/60Hz ± 5%	
Number of 10A lines	1	EFx-3-1600/3200 system
System Power Draw 1600 channels / 160 testers 3200 channels / 320 testers	 < 1 KVA/hour < 3 KVA/hour	

Table 10.0

11.0 System Heat Generation, Air Conditioning Requirements

Power	Requirement	
System Heat Generated 3200 Channels	Tbd KJ/hour	
System Air Flow TBD Configuration	Tbd	

Table 11.0

Notes: currently no measurements are available

11.1 System heat generation (depend on cabinet size)

To convert from heat generation, which
is specified in kilo-joules per hour, to air-cooling requirements, in British Thermal Units (BTU), perform the following calculation.

$$\frac{\text{System Heat Generated (in K Joules)}}{4186} \times 3.968 = \text{BTU's of Air Conditioning}$$

For example, for the first entry in the table,

$$\frac{47{,}100\text{KJ/hour}}{4186} \times 3.968 = 45\text{K BTU/hour}$$

Also, the system power draw, in kilowatts may be multiplied by 0.35 and the resulting value will be an estimate of the number of tons of air conditioning required.

11.2 EFx systems air flow direction

within test station as:

Standard Configuration

Test Station: Front in, Rear out EFx-3_1600/3200-6/10U, Manual, Fixture

Optional Configuration

Test Station: Rear in, Front Out EFx-3_1600/3200-6/10U, optional

12.0 Environmental Requirements

Parameter	Requirement
Temperature	
System Operating	+25°C ± 5°C
System Non-Operating	-20°C to +60°C
Relative Humidity	
System Operating	40% to 65%
System Non-Operating	20% to 90%
Vibration	
System Operating	Not measured (5Hz to 50Hz)
	Not measured (50Hz to 500Hz)
System Non-Operating	Not measured (5Hz to 50Hz)
	Not measured (50Hz to 500Hz)
Shock (during transport)	3G or less
Atmosphere	The ambient atmosphere must be free of salinity, iron, or corrosive gases.

Table 12.0

13.0 Compressed Air Requirement (depend on fixture system)

Parameter	Requirement
EFx Test System	
Pressure(t.b.d.)	xx x 10^4 Pa to xx x 10^4 Pa
	Yy kg/cm^2 to yy kg/cm^2
	zz to zz psi
Flow Rate	Not specified NL/minute

Table 13.0

Revision History

Revision	Comments	
1.01	Release V1.01 target specification	J.Jolly / F.Grossmann 2019-04-12
1.02	Release V1.02 target specification form	J.Jolly / F.Grossmann 2019-05-01
1.03	Release V1.03 interface specification	F.Grossmann 2019-06-01
1.04	Release V1.04 fotos EFx-3; EFx-3Mux	J.Jolly / F.Grossmann 2019-10-01
1.05	Release V1.05 Germann Patent	J.Jolly / F.Grossmann 2020-09-20
1.06	Release V1.06 US Patent	F.Grossmann 2022-05-03
1.061	Release V1.061 Photo update	F.Grossmann 2022-11-01
1.07	Release V1.07 NI Teststand Interface	U.Pohl / FGrossmann 2022-12-10
2.0	Release V2.0 update bugfix	F.Grossmann 2023-08-01