Arieh Nachum

Universal Training System
EB-3000

DEGEM®
SYSTEMS

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Universal Training System EB-3000

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Chapter 1 – EB-3000

1.1 About EB-3000

The EB-3000 is a frame trainer in sturdy plastic case for electronics and communication experiment plug-in cards.

The system includes all the lab instrument needed for electronics experiments: 5 voltages power supply (+12V, +5V, –5V, –12V and –12V to +12V variable voltage), 2 voltmeters, ampere-meter, frequency counter, logic probe, logic analyzer, two channel oscilloscope, function generator (sine, triangle and square wave signals).

The system includes a 3.2" color graphic display with touch panel for signal and measurement display.

The touch keyboard is used to program the scope and the function generator and the display options.

The system includes USB wire communication with the PC and a wireless modem for wireless communication to the master station in the lab.

A 20 key keyboard expands the keying options of the system.

The system includes 10 relays for switching the plug-in cards or for planting faults.

The plug-in cards are connected to the trainer through 48 pin industrial very low resistance connector.

Plugging an experiment board and unplugging it is simple and safe.

The system can be operated with or without a PC.

Each plug-in board has its own controller for automatic identification by the main platform, for saving its required configuration and for automatic self diagnostic.

1.2 Technical characteristics

The EB-3000 is a frame trainer in sturdy plastic case (36 x 26 cm) for electronics and communication experiment plug-in boards.

The system includes all the lab instruments needed for electronics experiments:

- 5 voltages power supply (+12V, +5V, –5V, –12V and –12V to +12V variable voltage).
- 2 voltmeters.
- Ampere-meter.
- Frequency counter up to 1MHz.
- Logic probe (High, Low, Open, Pulse, Memory).
- Logic analyzer with 8 digital inputs and trigger input.
- Two channel oscilloscope (with spectrum analysis while connecting to the PC).
- Function generator (sine, triangle and square wave signals) up to 1MHz.
- 3.2" color graphic display with touch panel for signal and measurement display.
- USB wire communication with the PC.
- 20 key terminal keyboard.
- 10 relays for switching the plug-in boards or for planting faults.
- 48 pin industrial very low resistance connector for plug-in boards connection.
- Transparent sturdy cover covers the upper part of the plug-in boards in order to protect the board's components that should be protected.

The system uses an external switching power supply for safety reasons. The power supply low voltage output is converted to the 5 voltages by linear regulators for noise reduction.

Two potentiometers on the panel are used to setup the variable voltage and the function generator amplitude.

The system cut-off the voltages in overload and displays a massage about that.

The plug-in experiment board is connected directly to system without any flat cable for noise and resistance reduction.

The system is controlled by an internal very powerful controller.

The 10 relays are change over relays that can switch active and passive components.

Every selecting of a relay configuration is saved in a non-volatile memory located on the connected plug-in board. The relay configuration will be set even if the board is disconnected from the system and reconnected or even when we turn the system's power OFF and then ON again.

The components are located on the experiment board with silk print of the analytical circuit and component symbols including all the circuit block drawings and all the hands on components, test points and banana sockets.

The experiment board components that should be protected are located on the upper side of the board, clearly visible to the student and protected by a sturdy transparent cover.

1.3 Boards and experiments

	Electricity and Electronics
EB-3121	Ohm and Kirchoff Laws and DC circuits
EB-3122	Norton, thevenin and superposition
EB-3123	AC circuits, signals and filters
EB-3124	Magnetism, electromagnetism, induction and transformers
	Semiconductor Devices
EB-3125	Diodes, Zener, bipolar and FET transistors characteristics and DC circuits
EB-3126	Bipolar and FET transistor amplifiers
EB-3127	Industrial semiconductors – SCR, Triac, Diac and PUT
EB-3128	Optoelectronic semiconductors – LED, phototransistor, LDR, 7-SEG.
	Linear Electronics
EB-3131	Inverter, non-inverter, summing, difference operational amplifiers
EB-3132	Comparators, integrator, differentiator, filter operational amplifiers
EB-3135	Power amplifiers
EB-3137	Oscillators, filters and tuned amplifiers
	Motors, Generators and Inverters
EB-3141	Analog, PWM DC motor speed control, step motor control, generators
EB-3142	Motor control – optical, Hall effect, motor closed control
EB-3143	Power regulators – linear and switching (up, down & inverter) regulators
	Digital Logic and Programmable Device
EB-3151	AND, OR, NOT, NAND, NOR, XOR logic components & Boolean algebra
EB-3152	Decoders, multiplexers and adders
EB-3153	Flip-flops, registers, and counters sequential logic circuits
EB-3154	555, ADC, DAC circuits
EB-3155	Logic families
	Microprocessor/Microcontroller Technology
EB-3191	Introduction to microprocessors and microcontrollers

A teacher guide, a student experiment manual and an evaluation manual accompany the system.

1.4 Board characteristics

All the experiment boards have the same characteristics as follows:

- Dimensions: 22 x 18 cm.
- Industrial 48 pin DIN connector.
- 2 board ejectors.
- Silk drawing of the circuit schematics.
- Banana test points for wire connections and measurements.
- Built-in microcontroler for board self-diagnostic and relay configuration setting that communicates with the EB-3000 main controller.

1.5 Board experiments

EB-3121 – Ohm and Kirchoff laws and DC circuits:

- Resistors and Ohm's law
- Voltage sources
- Resistors in series & 1st Kirchoff's law
- Voltage dividers
- Resistors in parallel & 2nd Kirchoff's law
- Current dividers
- Variable resistors (potentiometers, thermistors)
- Troubleshooting

EB-3122 – Norton, thevenin and superposition:

- Thevenin's theorem
- Norton's theorem
- Superposition theorem
- Voltage sources
- Maximum power transfer
- Troubleshooting

EB-3123 – AC circuits, signals and filters:

- AC waveform and signal parameters
- R circuits in alternat current
- Capacitors
- RC circuits
- Inductors
- RL circuits
- RLC resonance circuits
- RC filters
- RL filters
- Band pass filters
- Troubleshooting

EB-3124 – Magnetism, electromagnetism, induction & transformers:

- Magnetic fields
- Electricity and magnetism
- Magnetic self and mutual induction
- Magnetic penetrability
- Magnetic hystheresis
- Electromagnet
- Solenoid
- The transformer
- Troubleshooting

EB-3125 – Diodes, Zener, bipolar and FET transistors characteristics and DC circuits:

- Crystal diode characteristics, polarization and voltage
- Diode circuits
- Zener diode characteristics
- Zener diode as regulator
- The bipolar transistor types and characteristics
- The bipolar transistor DC circuits
- The FET types and characteristics
- The FET DC circuits
- Transistor as a switch
- Troubleshooting

EB-3126 – Bipolar and FET transistor amplifiers:

- Linear amplifier
- Measuring amplifier parameters
- Bipolar transistor h parameters (AC characteristics)
- Bipolar transistor amplifiers (CE, CE+Re, CB, emitter follower)
- FET g parameters (AC characteristics)
- FET amplifiers (CS, CS+Rs, source follower)
- Bi-stage amplifier
- Darlington amplifier
- Troubleshooting

EB-3127 – Industrial semiconductors – SCR, Triac, Diac and PUT:

- The SCR and its circuits
- The TRIAC and its circuits
- The DIAC and its circuits
- The PUT and its circuits
- Troubleshooting

EB-3128 – Optoelectronic semiconductors – LED, phototransistor, LDR, 7-SEG.:

- The LED and its circuits
- The 7-SEG. display and its circuits
- The Phototransistor and its circuits
- The LDR and its circuits
- Troubleshooting

EB-3131 – Inverter, non-inverter, summing, difference operational amplifiers:

- The operational amplifier and its characteristics
- The inverting amplifier
- Single supply voltage amplifier
- Non inverting amplifier
- Voltage to current converter
- Current to voltage converter
- Follower amplifier (unity amplifier, buffer amplifier)
- Summing amplifier
- Difference amplifier
- Troubleshooting

EB-3132 – Comparators, integrator, differentiator, filter operational amplifiers:

- Comparator amplifier
- A Schmitt trigger comparator
- Comparator applications
- Integrator amplifier
- Differentiator amplifier
- Band pass filter
- Troubleshooting

EB-3135 – Power amplifiers:

- Transistor power amplifier
- Class A, class B and class AB push-pull transistor amplifier
- Darlington power amplifiers
- Monolithic power amplifiers
- Troubleshooting

EB-3137 – Oscillators, filters and tuned amplifiers:

- Wien bridge oscillator
- A square wave oscillator
- A triangle wave oscillator
- Hartley oscillator
- Colppietz oscillator
- Tuned amplifier
- Troubleshooting

EB-3141 – Analog, PWM DC motor speed control, step motor control, generators:

- Electric motor for direct current
- DC motor speed control by analog voltage
- DC motor speed control by PWM
- Electric generator and dynamo
- Step motor control
- Troubleshooting

EB-3142 – Motor control – optical, Hall effect, motor closed control:

- Hall effect sensor (Hall generator)
- Optical RPM (position) sensor
- Motor open loop control
- Motor closed loop control
- Troubleshooting

EB-3143 – Power regulators – linear and switching (up, down and inverter) regulators:

- Half wave rectifier
- A full wave rectifier with center branch transformer
- A diode bridge rectifier
- Zener diode regulation
- Monolithic linear voltage regulator
- Step-Down switching regulator
- Step-Up switching regulator
- Inverter switching regulator
- DC-AC converter
- Troubleshooting

EB-3151 – AND, OR, NOT, NAND, NOR, XOR logic components & Boolean algebra:

- Logic components
- AND gate and its truth table
- OR gate and its truth table
- NOT gate and its truth table
- NAND gate and its truth table
- NOR gate and its truth table
- XOR gate and its truth table
- The rules of Boolean algebra
- The duality principle
- The XOR laws
- Constructing functions with NAND or NOR Gates
- Karnaugh map
- Simplifying functions by using the Karnaugh map
- Troubleshooting

EB-3152 – Decoders, multiplexers and adders:

- Designing a coder
- Integrated logic decoder
- Binary and BCD decoders
- 1 of n decoder
- The decoder as a decoder
- Primary and secondary decoding
- Using a decoder to materialize a function
- Mulitplexer and demultiplexer
- Transfer logic signal with logic gates
- Using a multiplexer to materialize functions
- Half adder and full adder
- Binary subtraction
- Troubleshooting

EB-3153 – Flip-flops, registers, and counters sequential logic circuits:

- S-R flip-flop
- D-Latch flip-flop
- J-K flip-flops
- T flip-flop
- D flip-flop
- Shift registers
- PISO and SIPO registers
- Ripple counters
- Modulo n and divide by n
- A binary synchronous counter
- A BCD synchronous counter
- Troubleshooting

EB-3154 – 555, ADC, DAC circuits:

- 555 monostable mode
- 555 astable mode
- Pulse width modulation
- Implementing a DAC with an operational amplifier & a resistor network
- A monolithic DAC
- ADC – materialized by a DAC
- A monolithic ADC
- Troubleshooting

EB-3155 – Logic families:

- Solid state devices – the major technologies
- The TTL family
- CMOS technology
- Input and output stages
- Gate characteristics
- Schmitt trigger
- Troubleshooting

EB-3191 – Introduction to microprocessors and microcontrollers:

- Structure of the microcomputer and principles of its operation
- Machine and assembly language with the 8051
- Input/output units
- Addressing modes
- Flags
- Programming
- Instructions and exercises
- Programmable ports
- Switches and keyboards
- 7-SEG. and LCD displays
- Troubleshooting

Chapter 2 – Measurements with EB-3000

2.1 Operating the system

Step 1: Connect the power supply to the EB-3000 and to the Mains.

Step 2: Switch on the EB-3000 system.

5 LEDs should turn ON on the top right.

The system includes 5 power supply outputs. The system checks these voltages and turns ON the LEDs accordingly.

+12V – Red LED
+5V – Orange LED
–5V – Yellow LED
–12V – Green LED

The fifth voltage is a variable voltage (Vvar) controlled by a slider potentiometer.

The LED of the Vvar is both green and red: when the Vvar voltage is positive – the color is red and when it is negative – the color is green.

Step 3: Check that all the LEDs are ON.

Step 4: Move the Vvar slider potentiometer from to left right and from right to left, and observe the Vvar LED and its color.

There are no outlets for the power supply voltages on the EB-3000 panel. The voltages are supplied only to the 48 pin connector.

The experiment boards take these voltages from the 48 pin connector.

Step 5: The system has 3 operating screens: DVM, Oscilloscope and Faults.

Moving from one screen to another is done by the Options/Graph key.

Press the Options/Graph key several times and observe the various screens.

Step 6: The keyboard is always at Num Lock position.

The keys can also be used as function keys.

In order to do so, we have to press once on the Num Lock key and then on the required key. The keyboard returns automatically to Num Lock mode.

Press the Option/Graph key until the scope screen appears.

Step 7: Press the Num Lock key and then the Digital key.

The screen is changed to Digital signal screen display.

Step 8: Press the Num Lock key and then the Analog key.

The screen is changed to Analog signal screen display.

2.2 Frequency counter

Step 1: Frequency is measured in the Cin inlet.

Find it.

Step 2: The EB-3000 includes a function generator.

The output of the square wave signal is the outlet with the square wave signal above it.

Connect the square wave outlet to the Cin inlet.

Step 3: Change the EB-3000 to DVM screen.

DVM

V1 [V]	V2 [V]
0.00	0.00
V2–V1 [V]	I [mA]
0.00	0.0
Fout [KHz]	Cin [Hz]
5.00	5.00
I (+5V) [mA]	I (+12V) [mA]
0	0
I (–5V) [mA]	I (–12V) [mA]
0	0

Num Lock

V1 is the voltage measured between V1 inlet and GND.

V2 is the voltage measured between V2 inlet and GND.

V2–V1 is the voltage measured between V1 and V2. It enables us to measure floating voltage.

I is the current measured between A+ and A– inlets.

Step 4: The frequency of the function generator is displayed in the Fout field and can be set by the arrow keys or by typing the required values.

Step 5: With your finger touch (press a little) the Fout field so it will be marked.

<u>Note:</u>

The system's reaction time (to touching or keying) is about one second. The reason for this slight delay is because the system is performing constant internal measurements and updating.

Step 6: Type the required frequency in Hertz (2000 for example) and press ENTER.

Step 7: Observe the frequencies of Fout and Cin.

Step 8: Change the Fout frequency by using the Up and Down arrows and observe the frequencies of Fout and Cin.

2.3 Function generator and oscilloscope

Step 1: The EB-3000 function generator outputs an analog signal and a square wave signal.

The square wave outlet is marked with the sign ⎍ .

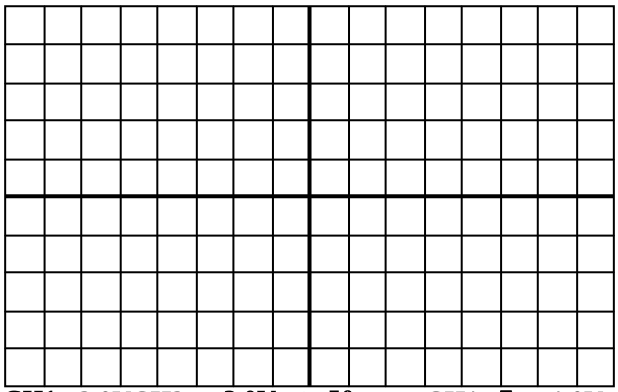
Near the analog signal outlet there is a sine/triangle switch marked with the signs /\/ / ∼.

Connect the analog signal outlet to the CH1 inlet.

Step 2: Connect the square wave outlet to the CH2 inlet.

Step 3: Set the Sine/Triangle switch to sine position.

Step 4: Change the screen to scope display.



CH1 3.0V CH2 3.0V t 50µs CH1 ⎍ 1.0V

Num Lock Analog Run

The scope and the display parameters (CH1 Volt/div, CH2 Volt/div, time base Sec/div, Trigger Channel, Trigger rise/fall, Trigger Level) appear on the bottom of the screen.

Observe that.

Step 5: The Up and Down arrow keys highlight one of the fields below.

Check that.

Step 6: You can highlight the required field by touching it.

Check that.

Step 7: Highlight the CH1 Volt/div and change it using the Up and Down keys.

Observe the effect on the signal display.

Step 8: Highlight the time base Sec/div and change it using the Up and Down keys.

Observe the effect on the signal display.

Step 9: The function generator amplitude is changed by the amplitude potentiometer.

Change the signal amplitude and observe the LCD display.

Step 10: To change the signal frequency you have to press the Options/Graph key and to change to the DVM screen and then change it as described in section 2.2.

Change the signal frequency, return to the scope screen and change the time base.

Step 11: Change the Sine/Triangle switch to triangle position and observe the signal on the LCD display.

Step 12: The sampling and display can be stopped.

Press the Num Lock key and then press the Stop (8) key.

The word **stop** will appear on the bottom of the screen and the sampling will be stopped.

Step 13: Performing a single sampling is done by pressing the Num Lock key and then pressing the Single (9) key.

The work **run** appears (for a short time) on the bottom of the screen. The system performs one sampling cycle and then stops.

Step 14: To perform again the sampling, press the Num Lock key and then press the Run (7) key.

2.4 Logic analyzer

The logic analyzer includes 8 digital inlets and one trigger signal inlet.

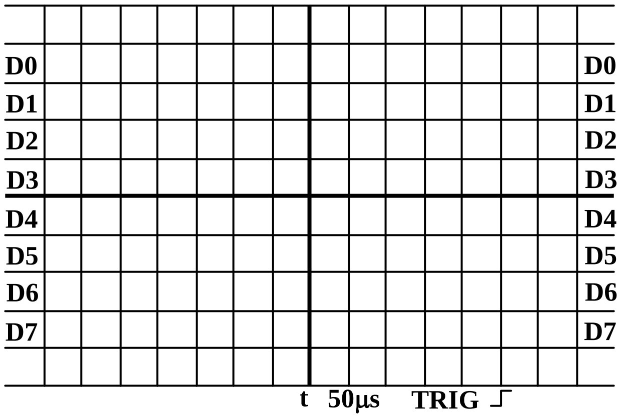
The controller waits for trigger and when it encounters a trigger pulse it samples the 8 digital inputs.

If a trigger pulse is not found the sampling will be according to the time base.

Step 1: Press the Options/Graph key until the scope screen appears.

Step 2: Press the Num Lock key and then the Digital key.

Step 3: The display is changed to Digital signal screen display.



Num Lock Digital Run

Check that.

Step 4: Connect the square wave outlet to the Tr trigger inlet using a banana wire.

Step 5: Highlight the time base Sec/div and change it using the Up and Down keys.

Observe the effect on the signal display.

Step 6: The sampling and display can be stopped.

Press the Num Lock key and then press the Stop (8) key.

The word **stop** will appear on the bottom of the screen and the sampling will be stopped.

Step 7: Performing a single sampling is done by pressing the Num Lock key and then pressing the Single (9) key.

The word **run** appears (for a short time) on the bottom of the screen. The system performs one sampling cycle and then stops.

Step 8: To again perform the sampling, press the Num Lock key and then press the Run (7) key.

Step 9: Connect another banana wire to the square wave outlet outlet.

Step 10: Touch with the banana plug on the other side on the digital input (D0 to D7) and observe the display.

2.5 Logic Probe

Step 1: The EB-3000 Logic Probe includes 5 LEDs indicating the Logic Probe (LP) input state – High, Low, Open (unconnected), Pulses and Memory (registering single pulse).

The Logic Probe also has a TTL/CMOS switch that determines which logic level is selected.

Observe that.

Step 2: Connect a banana plug wire to the LP inlet.

Step 3: Touch with the banana plug on the other side on the GND inlet.

The L green LED should turn ON.

When the banana plug will touch a point with a voltage blow 0.8V (for TTL) or 1.3V (for CMOS), the L green LED should turn ON.

When the banana plug will touch a point with a voltage above 2.0V (for TTL) or 3.7V (for CMOS), the H red LED should turn ON.

The voltage between these levels turns ON the OP orange LED.

Step 4: Touch with the banana plug on the other side on the square wave outlet.
The P yellow LED should blink.

Step 5: Disconnect the banana plug from the square wave output.

The M (Memory) LED should be ON. Press RST in order to switch it OFF.

2.6 Voltage sources

The EB-3000 includes 5 voltage sources:

- +12V/0.5A
- +5V/1A
- –5V/0.5A
- –12V/0.5A
- Vvar – variable voltage source from +12V/0.5A

The system gets its power from an external power supply of 15V/4A.

The system internal power supply is composed of two parts – switching regulators and linear regulators.

The system uses linear regulators as front regulators in order to avoid noise on the voltage lines.

The linear regulators supply the required voltages to the 48 pin connector.

The switching regulators create the input voltages for the linear regulators designed for minimum heat dispersing.

One of the system controllers control the current consumption of each regulator and shuts-off the regulator when it is over loaded.

The current consumed by each regulator is displayed on the DVM screen.

The above described voltages are only for the experiment boards. The system uses another built-in power supply. In this way, faults in the experiment board do not affect the EB-3000 operation.

2.7 Fault insertion

The EB-3000 includes 10 relays for fault insertion or for switching external components.

The fault screen is selected by the Options/Graph key.

FAULTS

Please choose
Fault No.: 0–9

Activated fault
Number: 0

Num Lock

Typing a fault number and pressing ENTER operates the required relay for the required fault.

Fault No. 0 means No Fault.

Which relay creates the required fault is registered in the plug-in experiment board controller.

On entering a fault number, the system addresses the experiment board controller and asks for the relay number. After that, it executes the required fault.

The experiment board controller saves the last registered fault number in its memory. This memory is non-volatile.

This is why the system does not allow us to enter a fault number when no experiment board is plugged.

When an experiment board that a certain fault (other than zero) is registered in its memory is plugged into the system, a warning message appears on the system's screen.

This feature enables the teacher to supply the students various experiment boards with planted faults for troubleshooting.

<u>Note:</u>

It is recommended (unless it is otherwise required), to return the experiment board fault number to zero before unplugging it.

2.8 Plugging an experiment board

The experiment board gets its power from the 48 pin connector.

When the board is powered, the controller of the board automatically checks the board modules.

After that, it communicates with the main controller of the EB-3000.

It sends its name and its software version.

If a problem in one or more of the modules is found, it tells it to the EB-3000 and a message (such as the following one) appears:

Faults in board
B1 OK
B2 OK
B3 NOT OK
B4 OK
B5 OK
B6 OK
B7 OK
B8 OK

If there are no faults, the DVM screen appears.

On the EB-3000, beneath the experiment board, there is a special fixed board with holes. The banana sockets holes of the experiment board are in accordance with the holes of this special board. The reason for this extra board with holes is to stabilize the banana plugs.

Note:

Take care to remove all the banana plugs before removing the experiment board.