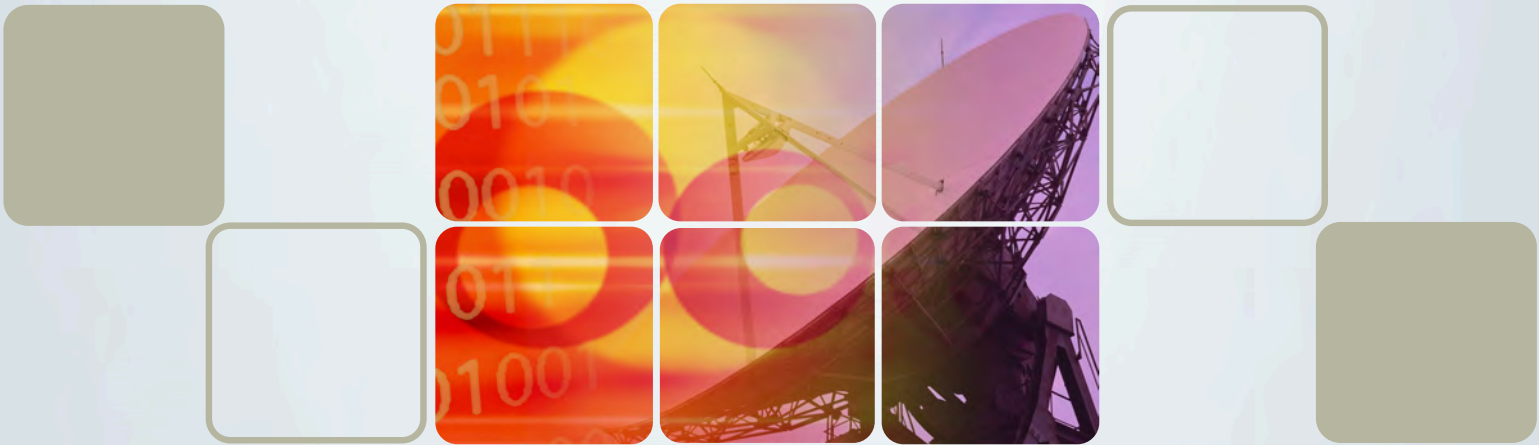




Communication System





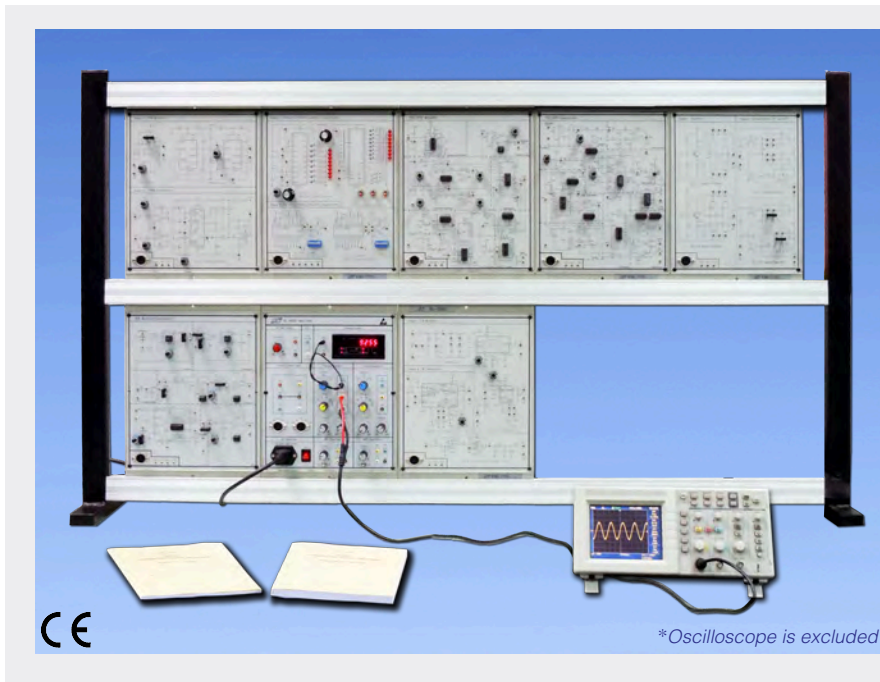
CONTENTS

KL-900A	Basic Communication System	1
KL-900B	Analog Communication System	6
KL-900C	AM/FM/ASK/FSK Transmitter & Receiver System	8
KL-900D	Fiber Optic Transmission Training System	10
KL-900E	Near Field Communication (NFC) Trainer	12
KL-910	Advanced Communication System.....	14
KL-920	Advanced Digital Communication System	19
EMC-100	EMI Training System.....	23



KL-900A

Basic Communication System



KL-900A offers experiments for fundamental technical concepts on telecommunication.

It enables students to acquire a clear experimental view and, further, they will be familiar with the operational aspects of the work in the telecommunication laboratory.

**Oscilloscope is excluded*

● Features

1. The trainer includes modules with experimental circuits. It offers the beginner complete courses in basic analog and digital communication.
2. KL-900A is equipped with power supply and signal unit. Students only have to adopt the oscilloscope to complete various experiments independently.
3. System modularity maximizes flexibility and variety for experimentation, and allows the possibility for expansion and customization.

● Specifications

Experiment Modules



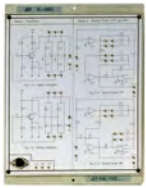
1. 2mm connection leads are used throughout the system.
2. The building blocks and components symbols of the circuits are printed on the surface of each module.
3. All modules are secured in plastic housings (297 x 226 x 60mm).
4. Cabinet is available for all modules storage facilities
5. Complete experimental manual and teacher's guide

List of Modules

1. Analog Communication Modules (KL-900A1)
 - (1) KL-93001 Oscillator/Second Order LPF & HPF
 - (2) KL-93002 AM Modulator/Demodulator
 - (3) KL-93003 DSB-SC & SSB Modulator/Demodulator
 - (4) KL-93004 FM Modulator/Demodulator
 - (5) KL-93005 PLL Frequency Synthesizer
 - (6) KL-93006 TDM&PAM-TDM Multiplexer/Demultiplexer
 - (7) KL-93007 FDM Multiplexer/Demultiplexer
 - (8) KL-93008 Signal Converter/Recovery/Regeneration
2. Digital Communication Modules (KL-900A2)
 - (1) KL-94001 A/D, D/A Converter Applications
 - (2) KL-94002 PWM Modulator/Demodulator
 - (3) KL-94003 FSK Modulator/Demodulator
 - (4) KL-94004 CVSD Modulator/Demodulator, Manchester Code Encode/Decode
 - (5) KL-94005 ASK Modulator/Demodulator
 - (6) KL-94006 PSK/QPSK Modulator
 - (7) KL-94007 PSK/QPSK Demodulator
3. Power Supply & Signal Generator Unit
KL-96001 Main Unit



Analog Communication Modules



KL-93001



KL-93002



KL-93003



KL-93004



KL-93005



KL-93006



KL-93007



KL-93008

1. KL-93001 Oscillator/Second Order LPF & HPF

- (1) RF oscillator
 - a. Oscillator frequency : 500KHz , 10MHz
 - b. Power supply : +12V
- (2) Second order LPF and HPF
 - a. Low pass -3db frequency : 1KHz , 10KHz
 - b. High pass -3db frequency : 800Hz , 8KHz
 - c. Power supply : +12V , -12V

2. KL-93002 AM Modulator/Demodulator

- (1) AM modulator
 - a. Carrier signal : 100KHz ~ 2MHz
 - b. Audio signal : 1KHz ~ 3KHz
 - c. Power supply : +12V, -5V
- (2) AM demodulator
 - a. Carrier signal : 100KHz ~ 2MHz
 - b. Audio signal : 1KHz ~ 3KHz
 - c. Power supply : +12V, -12V

3. KL-93003 DSB-SC & SSB Modulator/Demodulator

- (1) DSB-SC and SSB modulator
 - DSB-SC modulator
 - a. Carrier signal : 500KHz ~ 1MHz
 - b. Audio signal : 1KHz ~ 2KHz
 - c. Power supply : +12V, -5V
 - SSB modulator
 - a. Carrier signal : 453KHz
 - b. Audio signal : 1KHz ~ 2KHz
 - c. Power supply : +12V, -5V
- (2) DSB-SC and SSB demodulator
 - DSB-SC demodulator
 - a. Carrier signal : 500KHz
 - b. Audio signal : 1KHz ~ 3KHz
 - c. Power supply : +12V
 - SSB demodulator
 - a. Carrier signal : 453KHz
 - b. Audio signal : 2KHz
 - c. Power supply : +12V

4. KL-93004 FM Modulator/Demodulator

- (1) Frequency modulator
 - MC 1648 modulator
 - a. Carrier signal : 2MHz ~ 3MHz
 - b. Audio signal : 3KHz ~ 8KHz
 - c. Power supply : +5V
 - LM566 modulator
 - a. Carrier Signal : 2KHz ~ 20KHz
 - b. Audio Signal : 1KHz ~ 5KHz
 - c. Power Supply : +5V, -5V
- (2) Frequency demodulator
 - LM565 demodulator
 - a. Carrier signal : 2KHz ~ 20KHz
 - b. Audio signal : 1KHz ~ 5KHz
 - c. Power supply : +5V, -5V
 - FM-to-AM demodulator
 - a. Carrier signal : 500KHz ~ 2MHz
 - b. Audio signal : 1KHz ~ 5KHz
 - c. Power supply : +5V, -5V

5. KL-93005 PLL Frequency Synthesizer

- (1) Frequency selection range : 1KHz ~ 1.5MHz
- (2) Reference frequency : crystal OSC., 1KHz or 10KHz
- (3) Phase detector & VCO : IC 4046
- (4) Adjustable capture range
- (5) Adjustable lock-in range
- (6) With 5 module blocks
 - a. Reference frequency block
 - b. Phase locked loop block
 - c. Divided by N counter block
 - d. Divided by 10 block
 - e. Offset oscillator block
- (7) Divide-by-N counter is programmable by a thumbwheel switch

6. KL-93006 TDM & PAM-TDM Multiplexer/Demultiplexer

- (1) TDM multiplexer
 - Audio signal generator
 - a. Triangle generator : 100Hz ~ 15KHz, 6Vpp
 - b. Square generator : 100Hz ~ 15KHz, 6Vpp
 - c. Sine generator : 800Hz ~ 65KHz, 6Vpp
 - Analog switch multiplexer
 - a. TDM channel : channel A, B, C 3 ports
 - b. TDM switch frequency: 1MHz, 50KHz, 5KHz, 1KHz
 - TDM frame generator :
 - I . FSYNO : TDM frame synchronous transmit pulse TTL level
 - II . FCLKX : TDM transmit data clock TTL level
 - III . FSX : TDM data frame transmit synchronous pulse TTL level
 - d. TDM frame auto start level for synchronization
- (2) High speed analog PAM-TDM multiplexer
 - Audio signal PAM-TDM simultaneous multiplexer



- (3) Multichannel TDM simultaneous demultiplexer
 - Analog switch demultiplexer
 - a. TDM Mix signal level 6Vpp
 - b. Switch voltage level 6Vpp
 - c. TDM switch frequency : 1MHz, 50KHz, 5KHz, 1KHz
 - d. FSYNI : TDM frame start input
 - e. Auto start frame detector
 - TDM demultiplexer output : channel A, B, C 3 ports
 - TDM frame receiver counter : F0 ~ F7 (8-bit LED)

7. KL-93007 FDM Multiplexer/Demultiplexer

(1) FDM multiplexer

- FDM multiplexer channel : channel A,B,C 3 ports
- Wien bridge audio signal generator
 - a. Variable sine generator : 2KHz ~ 50KHz, 0~6Vpp
 - b. Fixed sine generator : 3.3KHz, $\pm 10\%$, 0~6Vpp
 - c. Fixed sine generator : 1KHz, $\pm 10\%$, 0~6Vpp
- Hartley carrier signal generator
 - a. Adjustable carrier generator : 450KHz~550KHz, 0~6Vpp
 - b. Adjustable carrier generator : 270KHz~330KHz, 0~6Vpp
 - c. Fixed carrier generator : 100KHz, $\pm 5\%$, 0~6Vpp
- AM modulator
 - a. Carrier signal : 100KHz ~ 500KHz
 - b. Audio signal : 1KHz ~ 20KHz
 - c. Modulation rate & level : 10% ~ 100%
 - d. FDM high bandwidth SUM : 1Hz ~ 1MHz

(2) FDM demultiplexer

- FDM demultiplexer channel: channel A,B,C 3 ports
- AM band tune
- Carrier bandpass filter BPF : 3 channel input : 3Vpp
- Channel A : 500KHz Adj. $\pm 20\%$, BW : 100KHz, $\pm 10\%$
- Channel B : 300KHz Adj. $\pm 20\%$, BW : 100KHz, $\pm 10\%$
- Channel C : 100KHz Adj. $\pm 20\%$, BW : 100KHz, $\pm 10\%$
- AM demodulator
 - a. AM rectifier
 - b. Adjust LPF
 - LPF A : Min : 1KHz Adj. $\pm 20\%$, Max : 30KHz Adj. $\pm 20\%$
 - LPF B : Min : 1KHz Adj. $\pm 20\%$, Max : 30KHz Adj. $\pm 20\%$
 - LPF C : Min : 250Hz Adj. $\pm 20\%$, Max : 2.5KHz Adj. $\pm 20\%$
- c. FDM demultiplexer audio signal output
 - Channel A : Sine : 3KHz ~ 20KHz, $\pm 10\%$
 - Channel B : Sine : 3KHz, $\pm 10\%$
 - Channel C : Sine : 1KHz, $\pm 10\%$

8. KL-93008 Signal Converter/Recovery/Regeneration

(1) Quadrature audio generator

- a. Frequency range : 300Hz ~ 10KHz
- b. Analog output level : 7Vpp
- c. Analog output : $\text{SIN}(\omega t)$, $\text{COS}(\omega t)$
- d. Analog distortion < 0.1%
- e. Digital output : two signals with 90° phase different

(2) Up/down frequency converter

- a. Multiplier
 - Frequency A input : 10KHz ~ 1MHz
 - Frequency B input : 10KHz ~ 1MHz
- b. Second order LPF down converter : 1KHz ~ 120KHz
- c. Second order HPF up converter : 330KHz ~ 1MHz
- d. External input LPF & HPF for other up/down converter

(3) Carrier signal recovery

- a. Up converter for double carrier input : $V_{in}(\text{min}) : 0.5V_{pp}$
- b. PLL & PLL/2
- c. Adjustable second order LPF : remove harmonic for carrier (sine) signal recovery
- d. Adjust phase shift : 0 ~ 150 degrees phase shift (as input frequency is 10KHz)

(4) Synchronal clock recovery

- a. Manchester encoder enclosed synchronal signal
- b. Clock XOR and clock delay for clock periodic detector
- c. PLL for synchronal clock recovery output

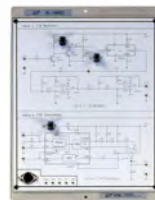
Digital Communication Modules



KL-94001



KL-94002



KL-94003



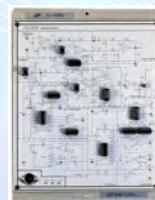
KL-94004



KL-94005



KL-94006



KL-94007



1. KL-94001 A/D, D/A Converter Applications

- (1) Analog to digital converter
 - a. Resolution : 8-bit or 256 steps
 - b. Clock frequency : 100KHz~800KHz
 - c. Input voltage range : 0~5V
 - d. Power supply : +5V
- (2) Digital to analog converter
 - a. Digital input : 8-bit
 - b. Output voltage type : single or bipolar
 - c. Power supply : +12V, -12V

2. KL-94002 PWM Modulator/Demodulator

- (1) PWM modulator

LM741 PWM

 - a. Carrier signal : 1.5KHz~2KHz
 - b. Audio signal : 500Hz
 - c. Power supply : +12V, -12V

LM555 PWM

 - a. Carrier signal : 5KHz~10KHz
 - b. Audio signal : 1KHz
 - c. Power supply : +12V
- (2) PWM demodulator
 - a. Audio signal : 500Hz~700Hz
 - b. Modulation signal : 5KHz~6KHz
 - c. Demodulation signal : 500Hz~700Hz
 - d. Power supply : +12V

3. KL-94003 FSK Modulator/Demodulator

- (1) FSK modulator
 - a. "SPACE" signal : 1270Hz
 - b. "MARK" signal : 1070Hz
 - c. Output voltage : 0~5V
 - d. Power supply : +12V, -12V
- (2) FSK demodulator
 - a. "SPACE" signal : 1270Hz
 - b. "MARK" signal : 1070Hz
 - c. Output voltage : 0~5V
 - d. Power supply : +5V, -5V

4. KL-94004 CVSD Modulator/Demodulator, Manchester

Code Encode/Decode

- (1) CVSD modulators & demodulators
- (2) Manchester code encode & decode
 - a. Encode of Manchester code
 - b. Decode of Manchester code
- (3) Line Code format : NRZ
- (4) Adjustable clock generator : 50KHz ~ 100KHz
- (5) Adjustable low pass filter

5. KL-94005 ASK Modulator/Demodulator

- (1) ASK modulator
 - a. Carrier signal : 20KHz~200KHz
 - b. Modulated signal : 1KHz~10KHz

(2) ASK demodulator

- Asynchronous envelope detector of ASK demodulator
- a. Carrier signal : 20KHz~200KHz
 - b. Modulated signal : 1KHz~10KHz
- Synchronous product detector of ASK demodulator
- a. Carrier signal : 20KHz~200KHz
 - b. Modulated signal : 1KHz~10KHz

6. KL-94006 PSK/QPSK Modulator

- (1) PSK/QPSK Modulator

Production & measurement of data stream of QPSK

Data speed : 400bps ~ 1000bps

QPSK modulator

 - a. Carrier signal : 7KHz
 - b. Data speed : 400bps

7. KL-94007 PSK/QPSK Demodulator

- (1) PSK/QPSK demodulator
 - a. Carrier signal : 7KHz
 - b. Data speed : 400bps

Power Supply & Signal Generator Unit

1. KL-96001 Main Unit



KL-96001

(1) Dual function generators

- Output waveform : sine, triangle, square and TTL level signal
- Output voltage
- a. 1Hz~50KHz : 0~20Vpp, continuously adjustable
 - b. 50KHz~200KHz : 0~16Vpp, continuously adjustable
 - c. 200KHz~500KHz : 0~10Vpp, continuously adjustable
- Output frequency : 6 ranges, selectable
- a. 1Hz~10Hz, continuously adjustable
 - b. 10Hz~100Hz, continuously adjustable
 - c. 100Hz~1KHz, continuously adjustable
 - d. 1KHz~10KHz, continuously adjustable
 - e. 10KHz~100KHz, continuously adjustable
 - f. 100KHz~500KHz, continuously adjustable
- All above ranges are adjusted by a 10-turn fine tuning knob
- AM modulation signal
- a. Input amplitude : 0~5Vpp
 - b. Input frequency range : 1Hz~100KHz
 - c. Percentage modulation : 80%
 - d. Output : AM amplitude continuously adjustable
- FM modulation signal
- a. Input amplitude : 0~5Vpp
 - b. Input Impedance : 10K Ω
 - c. Max. modulation ratio : 50:1
- FSK modulation signal
- a. Input impedance : 10K Ω
 - b. Input $\leq 0.7V$ for low level, adjustable output frequency
 - Input $\geq 3V$ for high level, fixed output frequency



- (2) V/F converter
 - Input voltage : 0 ~ 20V
 - Output frequency : 0 ~ 20KHz
 - Conversion ratio : 1V = 1 KHz
- (3) Adjustable DC power supply
 - Output voltage : 0 ~ 20V, continuously adjustable
 - Max. output current : 100mA with overload protection
- (4) Fixed DC power supply
 - Output voltage : +5 V, -5V (rated current 500 mA)
 - Output voltage : +12V, -12V (rated current 500 mA)
- (5) Universal frequency/period counter
 - Function : logic probe, frequency, period, pulse width
 - Input frequency range (F) : 1 Hz ~ 99.99999 MHz
10 Hz ~ 100.00000 MHz
 - Input period range (TH&TL) : 0.01 μ s ~ 999999.99 μ s
1 μ s ~ 99999999 μ s
 - Input level : TTL, analog signal ($V_{in} = 2.2V_{pp}$)
 - Sampling time : 1 sec & 0.1 sec
 - Display : 8-digit, 7-segment display
- (6) Power input
 - AC 90V ~ 230V, 50Hz/60Hz

● List of Experiments

Analog Communication

1. RF oscillator experiment
2. Second order LPF & HPF experiment
3. AM modulator experiment
4. AM demodulator experiment
5. DSB-SC and SSB modulator experiment
6. DSB-SC and SSB demodulator experiment
7. FM modulator experiment
8. FM demodulator experiment
9. Frequency synthesizer
10. TDM multiplexer experiments
11. TDM demultiplexer experiments
12. FDM multiplexer experiments
13. FDM demultiplexer experiments
14. Frequency converter experiment
15. Carrier frequency recovery experiment
16. Manchester clock regeneration experiment

Digital Communication

1. Analog to digital experiment
2. Digital to analog experiment
3. PWM modulator experiment
4. PWM demodulator experiment
5. FSK modulator experiment
6. FSK demodulator experiment
7. CVSD modulators & demodulators
8. Manchester code encode/decode
9. ASK modulator/demodulator
10. PSK/QPSK modulator/demodulator

● Accessories (KL-98001)

Standard Accessories

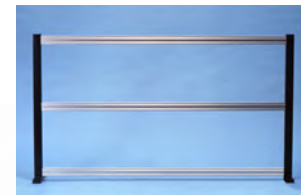
1. Connector Leads x 1 set
2. Experiment Manual x 1 pce
3. Teacher's Guide x 1 pce
4. Storage Cabinet x 2 sets (KL-99001)

Optional Accessories

1. Rack Frame (KL-89003)
2. Digital Storage Oscilloscope with FFT



Storage cabinet (KL-99001)



Option : Rack frame. (KL-89003)



KL-900B

Analog Communication System



144MHz VHF FM Transceiver Trainer

KL-900B Analog Communication System discloses the secret of the walky-talky based on the 144MHz VHF band. The circuitry of walky-talky is shown as blocks : receiver block, transmitter block, audio amplifier block and microphone amplifier block.

Block diagrams are printed clearly on the panel of the module, giving students a comprehensive view of how walky-talky works.

● Features

1. 144MHz VHF FM transceiver trainer
2. 2 modules construct the inner structure of the walky-talky, and cover more than 9 fully documented experiments.
3. Experiment and instructor's manual are included.

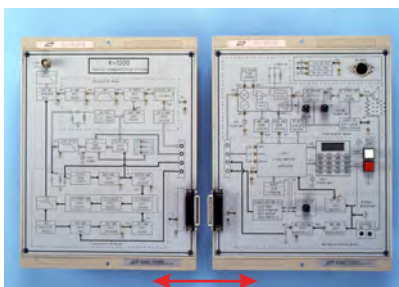
● Specifications

Experiment Modules

1. 2mm connection leads are used throughout the system
2. Building block diagrams are printed on the surface of each module.
3. Modules are secured in plastic housings (297 x 226 x 60mm)

List of Modules

Analog Communication System Module (KL-93051/KL-93052)



Analog Communication System Module (KL-93051/KL-93052)

1. General Characteristics

- | | |
|--------------------------|--|
| (1) Frequency range | : 144MHz~146MHz or
144MHz~148MHz |
| (2) PLL range | : 130MHz~170MHz |
| (3) Modulation type | : FM |
| (4) Channel setting step | : 5KHz, 10KHz, 12.5KHz,
20KHz, 25KHz, 50KHz |
| (5) Antenna impedance | : 50Ω |
| (6) Squelch sensitivity | : 0.16 μVmax |
| (7) Audio output | : 250mW |
| (8) Maximum offset | : ±5KHz |
| (9) 1st IF signal | : 21.8MHz |
| (10) 2nd IF signal | : 455KHz |

2. Key-Pad Function

- | | |
|------------------|--|
| (1) SQL | : to eliminate the "ZA" noise on FM |
| (2) Volume | : power switch/volume control |
| (3) TX/RX LED | : signal transmitter/receiver indicator;
red (transmitting) green (receiving) |
| (4) Channel | : channel selector |
| (5) M.S. socket | : external MIC or speaker |
| (6) Function key | |
| (7) PTT | : exchange between transmitting and receiving function |



● List of Experiments

1. Introduction to Analog Communication System
 - (1) Resetting the transceiver
 - (2) Setting the channel frequency
 - (3) Expanding frequency range
 - (4) Operating two keys
 - (5) Operating SET key
2. Microphone Amplifiers
 - (1) Measuring PTT DET output
 - (2) Measuring transmitted signal
 - (3) Measuring MIC-AMP (LIM) output
 - (4) Measuring MIC-LPF output
3. Phase-Locked Loops
 - (1) Measuring crystal oscillator output
 - (2) Measuring data, clock and LE in receiving
 - (3) Measuring data, clock and LE in transmitting
 - (4) Measuring phase comparator inputs
 - (5) Measuring phase comparator output
4. Voltage-Controlled Oscillators
 - (1) Measuring RX VCO characteristic
 - (2) Measuring TX VCO characteristic
5. RF Power Amplifiers
 - (1) Measuring TX POWER AMP input and output
 - (2) Measuring APC AMP input and output
6. RF Amplifiers
 - (1) Measuring RF AMP input
 - (2) Measuring RF AMP output
 - (3) Measuring BPF output
7. Mixers and IF Amplifiers
 - (1) Measuring RX VCO output
 - (2) Measuring 1st MIXER output
 - (3) Measuring CRYSTAL BPF output
 - (4) Measuring 1st IF AMP output
 - (5) Measuring 1st IF AMP input and output
8. FM Demodulators
 - (1) Measuring second mixer output
 - (2) Measuring 2nd FILTER output
 - (3) Measuring S-MET AMP output
 - (4) Demonstrating squelch control
9. Audio Amplifiers
 - (1) Measuring AF PREAMP input
 - (2) Measuring AF PREAMP output
 - (3) Measuring AF POWER AMP output

● Accessories(KL-98002)

1. Power Supply Module (SPS-001)
 - Fixed DC power supply
 - a. Output voltage : +5V, -5V, +12V, -12V
 - b. Output current : +5V/3A, -5V/0.3A, +12V/1.5A, -12V/0.3A
 - c. Output connector : 5 PIN DIN connector
 - d. With output overload protection
2. Teacher's Guide x 1 pce
3. Experiment Manual x 1 pce
4. VHF, FM Transceiver x 1 set

● Equipment Required

1. Digital Storage Oscilloscope (DSO) :
 - 100MHz bandwidth, 1GS/s sampling rate and FFT function or better
2. FM Signal Generator :
 - Capable of generating 130MHz~180MHz FM signal
3. AF Signal Generator :
 - Frequency range : 1Hz~10KHz
 - Waveforms : sine wave
 - Amplitude : 10Vp-p or better
4. Digital Multimeter



KL-900C

AM/FM/ASK/FSK Transmitter & Receiver System



The KL-900C AM/FM/ASK/FSK Transmitter and Receiver System is a comprehensive and self-contained system and is suitable for carrying out AM/ASK and FM/FSK transmission experiments.

The complete system contains KL-900C1 and KL-900C2, eight separated modules including:

- AM transmitter & receiver modules
- FM transmitter & receiver modules
- ASK/AM transmitter & receiver modules
- FSK/FM transmitter & receiver modules

● Features

1. System consists of ASK/AM transmitter and receiver, and FSK/FM transmitter and receiver.
2. Both AM & FM modules are equipped with 8-bit DIP switch for troubleshooting experiments.
3. Comprehensive experiment manual is provided.

KL-900C1

● Specifications

1. KL-93061A AM/DSB Transmitter
 - (1) AM transmitter for producing 1MHz
 - (2) 8-bit DIP switch for circuits fault simulations
2. KL-93062A AM Transistorized Radio
 - (1) AM receiver frequency range : 535KHz ~ 1605KHz
 - (2) Intermediate frequency : 455KHz
 - (3) 8-bit DIP switch for circuits fault simulations
3. KL-93063A FM Transmitter
 - (1) FM transmitter for producing 10.7MHz intermediate frequency
 - (2) 8-bit DIP switch for circuits fault simulations
 - (3) Digital logic probe : 1Hz~90MHz
4. KL-93064A FM Stereo Radio
 - (1) FM receiver frequency range : 88MHz-108MHz
 - (2) Frequency shown by 7 segment LED display
 - (3) 8-bit DIP switch for circuits fault simulations

● List of Experiments

AM Experiments

1. Sine Wave / Voice Modulator
2. Modulator Measurement
3. DSBSC / Sine Wave Pattern
4. Modulator Percentage
5. Trapezoid Pattern
6. Voice / Antenna Adjust
7. First IF Amplifier
8. Second IF Amplifier
9. Frequency Transmitter/Receiver & Modulator/Demodulator
10. Music Transmitter & Receiver

FM Experiments

1. Voltage Measurements of Varactor Diode
2. Crystal Oscillator Measurements
3. Frequency Multiplier Adjustments (For Second Harmonic)
4. RF Amplifier Tuning Circuit Adjustments (For Second Harmonic)
5. Frequency Multiplier Adjustments (For Third Harmonic)
6. RF Amplifier Tuning Circuit Adjustments (For Third Harmonic)
7. Audio Amplifier Measurements
8. Reference Oscillator Measurements
9. FM IF Amplifier
10. Counter
11. Music Transmitter & Receiver

● Accessories(KL-98003A)

- | | |
|--|---------|
| 1. CI -18001 Power Supply | x 2 pcs |
| (1) Output : +5V/0.5A, -5V/0.2A, ±12V/0.2A | |
| (2) Input : AC 110V/220V | |
| 2. Connection Leads and Plugs | x 1 set |
| 3. Telescopic Antenna | x 3 pcs |
| 4. Mini-microphone | x 2 pcs |
| 5. Experiment Manual | |
| 6. Digital Logic Probe | x 1 set |



KL-900C2

● Specifications

1. KL-93065 ASK/AM Transmitter
 - (1) Amplitude-shift keying (ASK) transmitter
Carrier frequency : 1.0MHz & 1.6MHz
 - (2) Data transmission format :
 - a. Start bit
 - b. 64-bit encoded data : 8-bit data encoded by 8-bit spread spectrum setting
 - c. Stop bit
 - (3) Data transmission :
 - a. Direct modulation
 - b. Manchester encoding
 - (4) Data rate :
 - a. 100Hz / 62.5Hz
 - b. 160Hz / 100Hz
 - c. 1.6K / 1KHz
 - (5) AM audio modulation signal :
Audio input : mono microphone input
2. KL-93066 ASK/AM Receiver
 - (1) AM receiver frequency range : 535KHz ~ 1605KHz
 - (2) Intermediate frequency : 455KHz
 - (3) Data receive mode :
 - a. Direct demodulation
 - b. Manchester decoding
 - (4) Data rate:
 - a. 100Hz / 62.5Hz
 - b. 160Hz / 100Hz
 - c. 1.6K / 1KHz
 - (5) AM audio demodulation signal :
Audio output : 0.2W 8Ω speaker
3. KL-93067 FSK/FM Transmitter
 - (1) Frequency-shift keying (FSK) transmitter, is able to produce 10.7MHz intermediate frequency.
 - (2) Data transmission format :
 - a. Start bit
 - b. 64-bit encoded data : 8-bit data encoded by 8-bit spread spectrum setting
 - c. Stop bit
 - (3) Data transmission :
 - a. Direct modulation
 - b. Manchester encoding
 - (4) Data rate :
 - a. 100Hz / 62.5Hz
 - b. 160Hz / 100Hz
 - (5) FM audio modulation signal :
Audio input : Mono microphone input
 - (6) Digital logic probe : 1Hz~90MHz
4. KL-93068 FSK/FM Receiver
 - (1) FM receiver frequency : 10.7MHz
 - (2) Data receive mode :
 - a. Direct demodulation
 - b. Manchester decoding
 - (3) Data rate:
 - a. 100Hz / 62.5Hz
 - b. 160Hz / 100Hz
 - (4) FM audio demodulation signal :
Audio output : 0.2W 8Ω speaker

● List of Experiments

ASK/AM Experiments

1. RF Amplifier Adjustment (Underlined Data are Reference Values)
2. Digital Data Coding (CDMA & Manchester Encoding)
3. Calibration of Transmitter and Receiver
4. Transmitter and Receiver Communication Experiment
5. Analog Transmission of Digital Signals
6. Analog Signal Transmitted by Analog Transmission
7. Music Signal Transmission

FSK/FM Experiments

1. Voltage Measurement of Varactor Diode
2. Crystal Oscillator Frequency Measurement
3. Frequency Multiplier Adjustment (Doubler)
4. Frequency Multiplier Adjustment (Tripler)
5. RF Amplifier Tuned Circuit Adjustment
6. Digital Data Transmission (Direct Sequence & Manchester Encoding)
7. Audio Amplifier Adjustment
8. Calibration of RF Amplifier
9. Receiver Frequency Detector Adjustment
10. Decoding Sequence Adjustment
11. Digital Data Transmission and Receiving (Direct Sequence & Manchester Encoding)
12. Digital Data Transmission and Receiving Example
13. Analog Transmission of Digital Signals
14. Analog Signal Transmitted by Analog Transmission
15. Music Signal Transmission

● Accessories (KL-98003B)

- | | |
|---|---------|
| 1. CI-18001 Power Supply | x 2 pcs |
| (1) Output : +5V/0.5A, -5V/0.2A,
±12V/0.2A | |
| (2) Input : AC 110V/220V | |
| 2. Connection Leads and Plugs | x 1 set |
| 3. Telescope Antenna | x 3 pcs |
| 4. Mini-microphone | x 2 pcs |
| 5. Experiment Manual | |
| 6. Digital Logic Probe | x 1 set |

KL-900C1 + KL-900C2

Storage cabinet (KL-99001)



KL-99001

Optional Accessory

Rack frame (KL-97003)



KL-97003



KL-900D

Fiber Optic Transmission Training System



* Notebook is excluded

Fiber Optic communication is one of the most popular technologies in the modern days due to its high transfer speed and large capacity. KL-900D uses fiber optic as a transmission media for the whole experiment.

Four different methods of data transmission (self-module transmission, module-to-module transmission, PC-to-module transmission and module-to-PC transmission) and various different modulation/demodulation methods (CVSD, ASK, etc.) are introduced in the training system. Users can obtain a clear view of how fiber optic transmission works.

● Features

1. Four different methods of data transmission (self-module transmission, module-to-module transmission, PC-to-module transmission, and module-to-PC transmission).
2. Demonstrating productive use of fiber optic materials.
3. Assembled equipment will transmit voice and light from one point to another traveling through an optical fiber.

● Specifications

Module (KL-95001)

1. Power : AC-DC Adapter
 - (1) AC input : 100V ~ 240V
 - (2) DC output : 15V, 500mA
2. Microphone Circuit
 - (1) Frequency range : 20Hz ~ 12KHz
 - (2) With gain amplified circuit
3. Push-button Switch
 - (1) N.O. Type
 - (2) With LED indication
4. Function generator
 - (1) Output sine wave with adjustable output amplitude
 - (2) Square wave from output transforming into CMOS level
 - (3) Frequency range : 6Hz ~ 2KHz
5. Output Speaker

8Ω, 1/4W
6. Transmitter
 - (1) Optical fiber light : red LED, $\lambda = 660\text{nm}$
 - (2) Max. drive current: 50mA
 - (3) Effective coupling micro-lens spotlight
 - (4) Emitter follower

7. Receiver

- (1) Optical receiving diode
 - a. λ peak : 880nm
 - b. Connectable plastic optical fiber with 1000 μm core
 - c. Effective coupling micro lens spotlight
 - d. Max. consumption power : 100mW
- (2) With amplified, gain, restoring -sharpness circuit

8. Data transmission elements

- (1) Chipset : AVR8515, 8-bit, 8MHz crystal
- (2) LCD : back-light 20 x 2 character
- (3) Keyboard : 4 x 4 16Key
- (4) Character mode : single letter or string letter available
- (5) Send mode : OFF (self module transmission), transceiver (module-to-module), PC to module, module to PC
- (6) With reset function
- (7) Communication interface : RS-232C, 9600 baud rate
- (8) Software environment : Windows base

Experiment Modules

1. 2mm connection leads are used throughout the system
2. Building blocks and components symbols of the circuits are printed on the surface of each module.
3. Modules are secured in plastic housings (255 x 165 x 30mm \pm 10%)
4. Comprehensive experimental manual
5. Bridge plugs inserted into circuit loop to reduce the possibility of errors



● List of Experiments

1. Fiber optics at the beginning
2. Applications of fiber optics
3. Light sources of fiber optics
4. Light and optical fiber interaction
5. Fiber optic transmitter
6. Fiber optic receiver
7. Fiber optic network and expand
8. Fiber optic connectors and fiber polishing
9. Data transmission - One module
10. Data transmission - Module to module
11. Data transmission - PC to module
12. Data transmission - Module to PC
13. CVSD data transmission (Optional)
14. ASK data transmission (Optional)
15. PSK/QPSK data transmission (Optional)

● Accessories(KL-98004)

1. 2mm-2mm test-lead x 1 set
2. Plastic Fiber Optics x 1 set
3. Experiment Manual
4. RS-232 to USB Adapter
5. Connection Plug Pitch = 10mm
6. Headphone and Microphone

● Option Modules

1. KL-96001 Main Unit
2. KL-94004 CVSD Modulator / Demodulator, Manchester Code Encode / Decode
3. KL-94005 ASK Modulator / Demodulator
4. KL-94006 PSK / QPSK Modulator
5. KL-94007 PSK / QPSK Demodulator



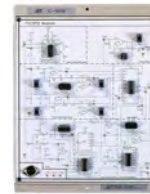
KL-96001



KL-94004



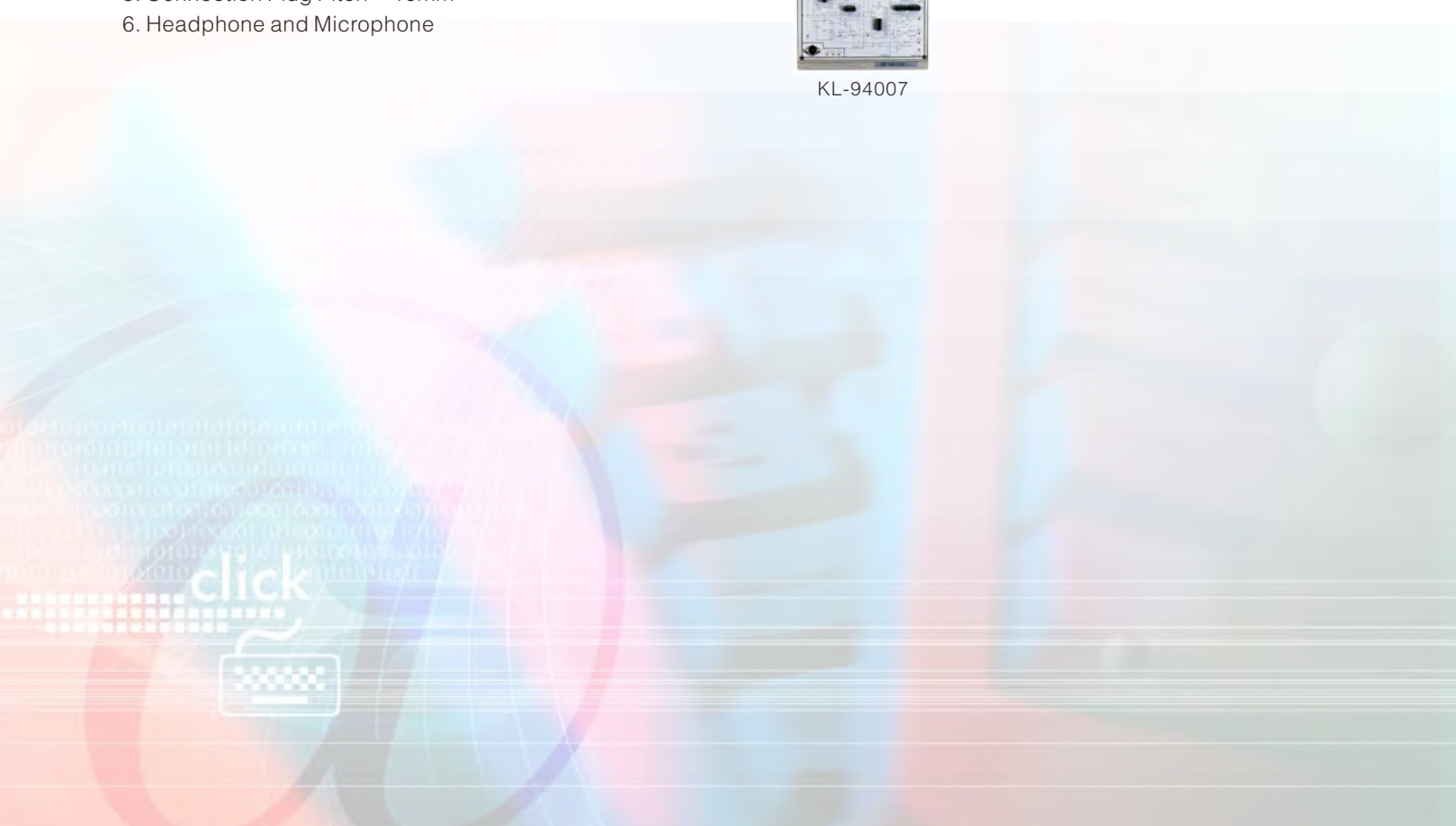
KL-94005



KL-94006



KL-94007





KL-900E

Near Field Communication (NFC) Trainer



NFC (Near Field Communication) is a type of short-range wireless technologies, with typical distance of 10 cm or less. NFC is compatible with existing passive RFID (13.56 MHz ISO/IEC 18000-3) infrastructures.

KL-900E NFC Trainer covers three parts: (1)NFC Principle of Transmission, (2)NFC and Contactless Smart Card and (3)NFC Appliance Integration. We hope to provide a complete learning experimental instrument for NFC that covers from physical to application layer for the novice.

Part I : NFC Principle of Transmission

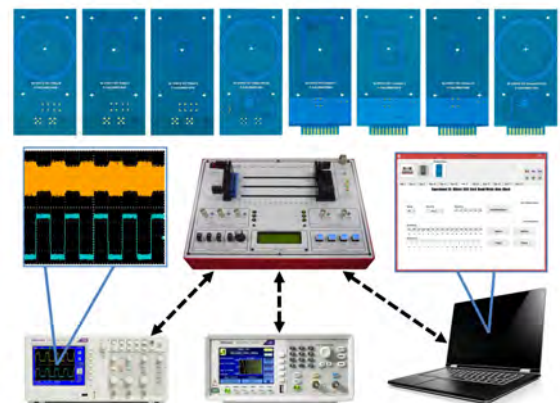
The radio frequency carrier signal plays an important role in NFC physical layer communication technology. Through FG and DSO of KL-900E trainer, students can generate radio frequency signals and observe waveform signals. In this part, they can understand the technique of LC circuit and Load modulation..., etc.

Part II : NFC and Contactless Smart Card

NFC devices can be used in contactless payment systems, similar to those currently used in credit cards and electronic ticket smartcards. It allows mobile payment to replace or supplement these systems. NFC standards cover communications protocols and data exchange formats, and are based on existing RFID standards including ISO/IEC 14443 and JISX6319-4. In this part, students can learn the technique of Mifare Card and Felica Card, ..., etc.

Part III : NFC Appliance Integration

In this part, students will learn the technique of NFC Tag, NFC Data Exchange Format(NDEF), NDEF vCard, P2P Message Transmission and P2P File Transmission.

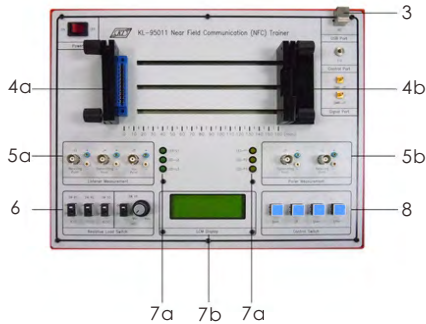


● Features

1. 8 antenna modules
2. Adjustable antenna module holder
3. LED/LCD/BUTTON user interface
4. Standard NFC SOC Module
5. Mifare S50 card and Ultralight card
6. NDEF, NDEF vCard and P2P data transmission, ...etc
7. Complete learning experimental instrument that covers NFC physical to application layer



● Specifications



Main Unit (KL-95011 NFC Trainer):

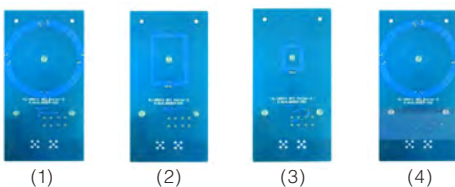
1. Input Power : 100V~240V, 50Hz~60Hz.
2. CPU : Microcontroller.
3. USB interface(Type B) : connect main unit with PC.
4. Adjustable antenna module holder :
 - (1) Left holder(listener end) : the gold fingers socket to connect main unit with listener module.
 - (2) Right holder(poller end) : the signal port and control port connect main unit with poller module.
5. Signal Measurement Connector :

Each measurement point contains one BNC connector and two 2mm connectors.

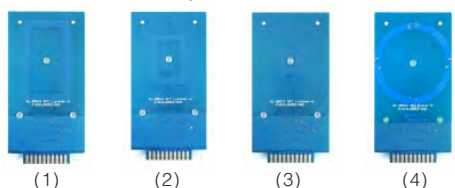
 - (1) Left measurement connector(listener end) : listener measurement end contains three measurement points.
 - (2) Right measurement connector(poller end) : poller measurement end contains two measurement points.
6. Resistive load switch : the resistive load switch contains three fixed resistors and one variable resistor.
7. Status Display :
 - (1) LED display.
 - (2) LCD display.
8. Control Switch : 4 push buttons.

List of Modules

1. NFC Poller Modules:
 - (1) NFC Poller 0 (KL-95012 NFC Poller-0)
 - (2) NFC Poller 3 (KL-95013 NFC Poller-3)
 - (3) NFC Poller 6 (KL-95014 NFC Poller-6)
 - (4) NFC Poller PN532 (KL-95018 NFC Poller-PN532)



2. NFC Listener Modules:
 - (1) NFC Listener 1 (KL-95015 NFC Listener-1)
 - (2) NFC Listener 3 (KL-95016 NFC Listener-3)
 - (3) NFC Listener 6 (KL-95017 NFC Listener-6)
 - (4) NFC Listener PN532 (KL-95019 NFC Listener-PN532)



● List of Experiments

Part I : NFC Principle of Transmission

- Coupled Transmission
 - Experiment 1 : Electromagnetic inductive coupling transmission
 - Experiment 2 : RF DC converter
- LC Characteristics
 - Experiment 3 : Resonant frequencies
 - Experiment 4 : Resonant frequency characteristics curve
- Load Modulation
 - Experiment 5 : Resistive load modulation
 - Experiment 6 : Carrier load modulation

Part II : NFC and Contactless Smart Card

- NFC ASK Modulation
 - Experiment 7 : NFC-A signal waveform measurement
 - Experiment 8 : NFC-B/F signal waveform measurement
- NFC Data Rate Experiment
 - Experiment 9 : NFC-A data rate experiment
 - Experiment 10 : NFC-B/F data rate experiment
- NFC Read Card ID
 - Experiment 11 : NFC-A read ID
 - Experiment 12 : NFC-F read ID
- NFC Read / Write Data Block
 - Experiment 13 : Mifare S50 card read/write data block
 - Experiment 14 : Ultralight card read/write data block

Part III : NFC Appliance Integration

- NDEF
 - Experiment 15 : NFC data exchange format
 - Experiment 16 : NDEF vCard
- P2P
 - Experiment 17 : P2P message transmission
 - Experiment 18 : P2P file transmission

● Accessories

1. Experiment Manual x 1 pce
2. CD x 1 pce
3. Mifare S50 Card x 2 pcs
4. Ultralight Card x 2 pcs
5. SMB Cable x 2 pcs
6. NFC Poller-PN532 Control Cable x 1 pce
7. Connect Leads x 1 set
8. USB Cable(Type A to Type B) x 1 pce

● Optional

1. Computer
 - (1) PC with pentium 4 or above
 - (2) Windows XP or upper version
 - (3) Experiment : 7,8,9,10,11,12,13,14,15,16,17,18
2. Digital Storage Oscilloscope
 - (1) 25MHz bandwidth
 - (2) 2 input channels
 - (3) Experiment : 1,2,3,4,5,6,7,8,9,10
3. Function Generator 1
 - (1) Wide frequency ranges from 1MHz ~ 25MHz (sine wave)
 - (2) Experiment : 1,2,3,4,5,6
4. Function generator 2
 - (1) Wide frequency 106KHz (square wave)
 - (2) Experiment : 6



KL-910

Advanced Communication System



* Notebook, Oscilloscope and Logic analyzer are excluded.

KL-910 is a modular trainer with various advanced communication experiments including digital encoding/decoding, modulation/demodulation and related multiplexing techniques. It's developed for bridging the gap between the theory and the practice of the modern communication system.

● Features

- Essential theories and techniques in modern communication system including digital encoding/decoding techniques, various digital serial ports, DTMF signal system, ASK/FSK/QPSK/TDM/PAM/FDM modulation/demodulation and filters...etc.
- KL-910 offers users not only the comprehensive experiments of advanced communication system but also various peripherals including analog/digital function generator, frequency meter, and V-F converter...etc. All of the experiments are carried out appropriately with the help of oscilloscope, spectrum analyzer and logic analyzer.

● Specifications

KL-96001 Main Unit

1. Dual Function Generators

- Output waveform : sine, triangle, square and TTL level signal
- Output voltage
 - 1Hz~50KHz : 0~20Vpp, continuously adjustable
 - 50KHz~200KHz : 0~16Vpp, continuously adjustable
 - 200KHz~500KHz : 0~10Vpp, continuously adjustable
- Output frequency : 6 range, selectable
 - 1Hz~10Hz, continuously adjustable
 - 10Hz~100Hz, continuously adjustable
 - 100Hz~1KHz, continuously adjustable
 - 1KHz~10KHz, continuously adjustable
 - 10KHz~100KHz, continuously adjustable
 - 100KHz~500KHz, continuously adjustable

All above ranges are adjusted by a 10-turn fine tuning knob

- AM modulation signal
 - Input amplitude : 0~5Vpp
 - Input frequency range : 1Hz~100KHz
 - Percentage modulation : 80%
 - Output : AM amplitude continuously adjustable
- FM modulation signal
 - Input amplitude : 0~5Vpp
 - Input Impedance : 10K Ω
 - Maximum modulation ratio : 50:1
- FSK modulation signal
 - Input impedance : 10K Ω
 - Input $\leq 0.7V$ for low level, adjustable output frequency
Input $\geq 3V$ for high level, fixed output frequency

2. V/F Converter

- Input voltage : 0~20V
- Output frequency : 0~20KHz
- Conversion ratio : 1V=1KHz

3. Adjustable DC Power Supply

- Output voltage : 0~20V, continuously adjustable
- Max. output current : 100mA with overload protection

4. Fixed DC Power Supply

- Output voltage : +5V, -5V (rated current 500mA)
- Output voltage : +12V, -12V (rated current 500mA)

5. Universal Frequency/Period Counter

- Function : logic probe, frequency, period, pulse width
- Input frequency range (F) : 1Hz~99.999999MHz
10Hz~100.000000MHz
- Input period range (TH&TL) : 0.01 μ s~999999.99 μ s
1 μ s~99999999 μ s
- Input level : TTL, analog signal ($V_{in} \geq 2.2V_{pp}$)
- Sampling time : 1 sec & 0.1 sec
- Display : 8-digit, 7-segment display

6. Power Input

- AC 90V~230V, 50Hz/60Hz



KL-96002 Clock/Data & Noise Generator

1. Clock Generator

- (1) Standard clock generator : 1MHz, 100KHz, 20KHz, 10KHz, 2KHz, 1KHz
- (2) Adjustable OSC. : 10Hz ~ 100KHz
- (3) Manual pulse generator

2. Data Synchronous Clock Generator

3. Sequential Data Generator

- (1) Sequence length : 64, 256, 1024, 2048
- (2) 16 bits parallel data output is displayed by LEDs.
- (3) 1-bit serial data output is available per input clock, TTL compatible, MSB first.
- (4) 2-bits (even bit+odd bit) serial data output is available per two input clocks.

4. Random Data Generator

- (1) Use 3-bit DIP switch to select a 16-bit random seed
- (2) 1-bit random data output is available per input clock, TTL level.
- (3) 8-bit parallel random data output is available per input clock, TTL level.
- (4) R-2R DAC & buffer for noise generator

5. 3-bit Unipolar to Bipolar

- (1) Input : UNI-A, UNI-B, UNI-C, TTL level
- (2) Output : HI = +3.3V, LO = -3.3V

KL-96003 Line-Code Encoder & Decoder

1. Line-Code Encoder

- (1) Data bit clock generator : $F_{max} \leq 1\text{MHz}$
Standard clock generator : 1MHz, 100KHz, 20KHz, 10KHz, 2KHz, 1KHz
- (2) Data bit generator
- (3) Data & clock is reset by external pulse or pushbutton.
- (4) Signal level unipolar : 0, +3V
Bipolar : -3V, +3V
3-level : -3V, 0, +3V
- (5) Standard TTL data is encoded using following line-code schemes :
 - a. NRZ-L(BIP) b. NRZ-M(BIP) c. UNI-RZ(UNI)
 - d. BIP-RZ(3L) e. RZ-AMI(3L) f. BI Φ -L(Manchester 3L)
 - g. DICODE-NRZ(3L)

2. Line-Code Decoder

- (1) Line decoder clock
- (2) Line decoder data input
 - a. NRZ-L(BIP) b. NRZ-M(BIP) c. UNI-RZ(UNI)
 - d. BIP-RZ(3L) e. RZ-AMI(3L) f. BI Φ -L(Manchester 3L)
 - g. DICODE-NRZ(3L)
- (3) Line decoder data : independently output, TTL level
 - a. NRZ-L b. NRZ-M c. UNI-RZ
 - d. BIP-RZ e. RZ-AMI f. BI Φ -L
 - g. DICODE-NRZ

KL-96004 Delta/Sigma/Adaptive Modulation&Demodulation

1. Delta Modulation

- (1) Sample clock selected by DIP switch
- (2) Data sample control output
- (3) 4-bit DAC(R-2R buffer) for adaptive delta modulation
- (4) Unipolar to bipolar level shift
Input : 0 ~ +3V ; Output : -3V ~ +3V
- (5) Integrator
 - a. Input : bipolar signal
 - b. Frequency range : 400Hz ~ 10KHz

(6) Hard limiter

- a. Zero crossing detector with threshold voltage of 0V
- b. Frequency range : 100Hz ~ 100KHz

(7) SUM. & SUB.

(8) Multiplier : for adaptive delta voltage control amplitude(VCA)

2. Delta Demodulation

- (1) Data sample control output
- (2) 4-bit DAB(R-2R buffer) for adaptive delta modulation
- (3) Unipolar to bipolar level shift Input : 0 ~ +3V,
Output : -3V ~ +3V
- (4) Integrator
 - a. Input : bipolar signal
 - b. Frequency range : 400Hz ~ 10KHz
- (5) RC LPF
Adjustable cut-off frequency : 2KHz ~ 20KHz

KL-96005 QPSK Modulation&QPSK Demodulation

1. QPSK-8PSK-8QAM Modulation

- (1) Data modulation source
16 bits parallel DIP switch data input
- (2) Modulation function 8PSK, 8QAM, QPSK
- (3) Unipolar to bipolar level shift
- (4) Amplitude modulation
- (5) I modulation multiplier
- (6) Q modulation multiplier
- (7) Linear adder QPSK (shift $\pi/4$)
- (8) Mode selector QPSK (No shift)
- (9) 8PSK modulation
- (10) 8QAM modulation

2. QPSK Demodulation

- (1) Signal squarer
- (2) Hard limiter
Zero crossing detector with threshold voltage of 0V
- (3) Phase locked loop (PLL)
- (4) Frequency divider
- (5) IQ-splitter
- (6) I- level discrimination
- (7) Q- level discrimination
- (8) Serial to parallel converter

KL-96006 DTMF Generator & Decoder/Controller

1. DTMF Generator

- (1) Scan keypad & display:
 - a. Input : 4x4 keypad
 - b. Scan display : 8-digit 7-segment display & LCDM 20 x 2
- (2) DTMF generator
- (3) 100 sets phone number storage

2. DTMF Decoder

- (1) Ring detector
- (2) DTMF decoder
 - a. DTMF decoder number display : LCDM 20 x 2
 - b. DTMF code compare with 2 LED output
- (3) DTMF code controller

Remark: 1. DTMF generator and DTMF decoder share the same LCDM.

2. To carry out more experiment computer is essential but extra.

KL-96007 Multi-Function Process Module (A)

1. Quadrature Audio Generator

Frequency range : 300Hz ~ 10KHz

2. Quadrature Phase Splitter

Input frequency range : 200Hz ~ 10KHz



3. Phase Shifter

- (1) Frequency range : high approx. 100KHz, low approx. 2KHz for 0 ~ 360 degrees of phase shift.
- (2) Coarse adjustment 0 ~ 180 degrees shift
- (3) Fine adjustment approx. 20 degrees shift

4. Tunable LPF & 2 Sets of Counter

- (1) Filter corner-frequency display :
2 range setting & 4-digit 7-segment display
Normal : 0.1Hz ~ 2.5KHz
Wide : 10Hz ~ 25KHz
- (2) LPF cut-off frequency attenuation > 60 dB
- (3) Width band VCO
- (4) External frequency counter range
High range : 1KHz ~ 9999KHz
Low range : 0.1KHz ~ 999.9KHz

5. 4-Channel Analog Multiplexer

- (1) Each channel DC offset : +6V, +2V, -2V, -6V
- (2) Input channel : 4 channels
- (3) Bandwidth : DC ~ 2MHz
- (4) Synchronous frequency
ALT : 1KHz ~ 500KHz
CHOP : 10Hz ~ 1KHz

KL-96008 Multi-Function Process Module (B)

1. Triple Analog Switch & Switch Sequencer Counter & TDM Modulation

- (1) Analog input bandwidth : DC ~ 300KHz
- (2) Control input level : TTL level

2. Dual Multiplier

- (1) Input gain : 1 ~ 5 adjustable
- (2) Bandwidth approx. DC ~ 1MHz
- (3) Offset Z : 0 ~ ±5V adjustable

3. TTL to Bipolar & Subtractor/Adder

- (1) Three sets of TTL to bipolar :
input TTL level, output -3V ~ +3V
- (2) Bandwidth approx. DC ~ 1MHz

4. Power Amplifiers & DIF. ENC./DEC.

- (1) Amplifier bandwidth : DC to approx. 1MHz
- (2) 8-bit DIP switch data for differential encoder & decoder

5. Dual RC LPF

- Corner frequency(-3dB) :
- LB : 100Hz ~ 1KHz
HB : 1KHz ~ 10KHz continuously adjustable

6. Dual Voltage Level Comparator

- (1) Input analog level : 0 ~ ±3V
- (2) Level adjustment : 2 level variable
V_{cph} : +5V ~ -4V, V_{cpl} : -5V ~ +4V
- (3) TTL level inverter

KL-93006 TDM & PAM-TDM Multiplexer / Demultiplexer

1. TDM Multiplexer

- (1) Audio signal generator
 - a. Triangle generator : 100Hz ~ 15KHz, 6Vpp
 - b. Square generator : 100Hz ~ 15KHz, 6Vpp
 - c. Sine generator : 800Hz ~ 65KHz, 6Vpp

(2) Analog Switch Multiplexer

- a. TDM channel : channel A, B, C 3 port
- b. TDM switch frequency : 1MHz, 50KHz, 5KHz, 1KHz
- c. TDM frame generator :
 - I . FSYNO : TDM frame synchronously transmit pulse, TTL level
 - II . FCLKX : TDM transmit data clock, TTL level
 - III . FSX : TDM data frame transmit synchronous pulse, TTL level
- d. TDM frame auto start level for synchronization, TTL Level

2. High Speed Analog PAM-TDM Multiplexer

Audio signal PAM-TDM simultaneous multiplexer

3. Multichannel TDM Simultaneous Demultiplexer

- (1) Analog switch demultiplexer
 - a. TDM mixed signal level : 6Vpp
 - b. Switch voltage level : 6Vpp
 - c. TDM switch frequency : 1MHz, 50KHz, 5KHz, 1KHz
 - d. FSYNI : TDM start frame (input TTL level)
 - e. Auto start frame detector : TTL level
- (2) TDM demultiplexer output : channel A, B, C 3 port
- (3) TDM frame receiver counter : F0 ~ F7 (8-bit LED)

KL-93007 FDM Multiplexer / Demultiplexer

1. FDM Multiplexer

- (1) FDM multiplexer channel : channel A, B, C 3 port
- (2) Wien bridge audio signal generator
 - a. Variable sine generator : 2KHz ~ 50KHz, 0 ~ 6Vpp
 - b. Fixed sine generator : 3.3KHz, ±10%, 0 ~ 6Vpp
 - c. Fixed sine generator : 1KHz, ±10%, 0 ~ 6Vpp
- (3) Hartley carrier signal generator
 - a. Adjustable carrier generator : 450KHz ~ 550KHz, 0 ~ 6Vpp
 - b. Adjustable carrier generator : 270KHz ~ 330KHz, 0 ~ 6Vpp
 - c. Fixed carrier generator : 100KHz, ±5%, 0 ~ 6Vpp
- (4) AM modulator
 - a. Carrier signal : 100KHz ~ 500KHz
 - b. Audio signal : 1KHz ~ 20KHz
 - c. Modulation rate & level : 10% ~ 100%
 - d. FDM high bandwidth SUM : 1Hz ~ 1MHz

2. FDM Demultiplexer

- (1) FDM demultiplexer channel : channel A, B, C 3 port
- (2) AM band tune
Carrier bandpass filter BPF : 3 channel input (3Vpp)
Channel A : 500KHz Adj. ±20%, BW : 100KHz, ±10%
Channel B : 300KHz Adj. ±20%, BW : 100KHz, ±10%
Channel C : 100KHz Adj. ±20%, BW : 100KHz, ±10%
- (3) AM demodulator
 - a. AM rectifier
 - b. Adjusting LPF
LPFA : Min. : 1KHz Adj. ±20%, Max. : 30KHz Adj. ±20%
LPFB : Min. : 1KHz Adj. ±20%, Max. : 30KHz Adj. ±20%
LPFC : Min. : 250Hz Adj. ±20%, Max. : 2.5KHz Adj. ±20%
- c. FDM demultiplexer audio signal output :
Channel A : Sine (3KHz ~ 20KHz, ±10%)
Channel B : Sine (3KHz, ±10%)
Channel C : Sine (1KHz, ±10%)



KL-93008 Signal Converter/Recovery/Regeneration

1. Quadrature Audio Generator
 - (1) Frequency range : 300Hz ~ 10KHz
 - (2) Analog output level : 7Vpp
 - (3) Analog output : SIN(ωt), COS(ωt)
 - (4) Analog distortion : < 0.1%
 - (5) Digital output : TTL, TTL with 90° phase shift
2. Up/Down Frequency Converter
 - (1) Multiplier
 - a. Frequency A input : 10KHz ~ 1MHz
 - b. Frequency B input : 10KHz ~ 1MHz
 - (2) Second order LPF down converter : 1KHz ~ 120KHz
 - (3) Second order HPF up converter : 330KHz ~ 1MHz
 - (4) External input LPF & HPF for other up / down converter
3. Carrier Signal Recovery
 - (1) Up converter for double carrier input : $V_{in(min)} : 0.5V_{pp}$
 - (2) PLL & PLL/2
 - (3) Adjustable second order LPF : remove harmonic for carrier (sine) signal recovery
 - (4) Adjust phase shift : 0 ~ 150 degrees phase shift
4. Synchronous Clock Recovery
 - (1) Manchester encoder enclosed synchronous signal
 - (2) Clock XOR and clock delay for clock periodic detector
 - (3) PLL for synchronous clock recovery output

List of Modules



KL-96001



KL-96002



KL-96003



KL-96004



KL-96005



KL-96006



KL-96007



KL-96008



KL-93006



KL-93007



KL-93008

List of Experiments

1. Main Unit (KL-96001)
 - (1) Signal measurement and experiment
 - (2) Signal modulating experiment
 - (3) Voltage to frequency converter
 - (4) Frequency and period measuring experiment
2. Clock / Data & Noise Generator (KL-96002)
 - (1) Measurement of clock generator
 - (2) Measurement experiment for synchronous data clock
 - (3) Detection of the data sequence output
 - (4) Measurement experiment of single-to-dual parallel output
 - (5) Measurement experiment for digital random number generator and analog noise generator
 - (6) Experiment of 3-bit unipolar to bipolar conversion
3. Line-Code Encoder & Decoder (KL-96003)
 - (1) Experiment with serial data sequence
 - (2) NRZ-L/BIP (None return to zero) encoding
 - (3) NRZ-M/BIP (None return to zero mark) encoding
 - (4) UNI-RZ/UNI (Unipolar return to zero) encoding
 - (5) BIP-RZ/3L (3 Level) encoding
 - (6) RZ-AMI/3L encoding
 - (7) Bi Φ -L/3L (Manchester) encoding
 - (8) DICODE-NRZ (3L) encoding
 - (9) NRZ-L/BIP Decoding
 - (10) NRZ-M/BIP decoding
 - (11) UNI-RZ/UNI decoding
 - (12) BIP-RZ/3L decoding
 - (13) RZ-AMI/3L decoding
 - (14) Bi Φ -L/3L(Manchester) decoding
 - (15) DICODE-NRZ (3L) decoding
4. Delta/Sigma/Adaptive Modulation & Demodulation(KL-96004)
 - (1) Experiment of delta modulation
 - (2) Experiment on the LPF of delta modulator
 - (3) Experiment of delta demodulation
 - (4) Adaptive-delta modulation & demodulation circuits
 - (5) Experiment on controlling voltage amplitude of integrator of adaptive-delta modulator/demodulator
 - (6) Experiment on controlling voltage amplitude of integrator of VGA adaptive-delta modulator/demodulator
 - (7) Experiment on delta-sigma modulation circuit
5. QPSK Modulation & QPSK Demodulation(KL-96005)
 - (1) Experiment on nPSK modulation sinusoidal signal source & synchronization data source
 - (2) Experiment on sinusoidal signal measurement with phase-shift circuit
 - (3) Experiment on quadrature phase splitter
 - (4) Experiment on BPSK analog signal modulation
 - (5) Experiment on BPSK demodulation



- (6) Experiment on synchronization of BPSK demodulation signal with SIN TTL and carrier signal restoring
- (7) Experiment on QPSK modulation
- (8) Experiment on 8PSK modulation
- (9) Experiment on 8QAM modulation
- (10) Experiment on QPSK demodulation with signal sampling identification

6. DTMF Generator & Decoder/Controller (KL-96006)

- (1) Keypad scanning & dialing experiments of DTMF
- (2) Storage and dialing of phone number on DTMF system
- (3) Demodulation experiment using internal DTMF signal
- (4) Password setting & decoding experiment using internal DTMF
- (5) Password setting & decoding experiment using external phone-line DTMF
- (6) DTMF control experiment using UART

7. Multi-Function Process Module(A) (KL-96007)

Multi-Function Process Module(B) (KL-96008)

- (1) Experiment with VCO and LPF
- (2) Experiment on LPF frequency response
- (3) Experiment of transforming Square waveform into sinusoidal waveform using LPF
- (4) Experiment on triple-state analog multiplexer and TDM
- (5) Experiment on four-channel analog multiplexer with level-shift configuration
- (6) Experiment on AM and double-side-band modulation
- (7) Experiment on SSB (Single-side-band) AM modulation
- (8) Experiment on AM Demodulation
- (9) The generation of accurate 45-degree phase shift
- (10) Experiment on BPSK and QPSK modulations
- (11) Experiment on BPSK demodulation
- (12) Level comparator
- (13) Experiment on Power amplifier
- (14) Experiment on ASK modulation
- (15) Experiment on ASK demodulation
- (16) Experiment on FSK modulation
- (17) Experiment on FSK modulation using VCO
- (18) Experiment on the Built-in FSK modulation function of function generator
- (19) Experiment on FSK modulation using digital VCO
- (20) Experiment on the conversion from FSK to ASK
- (21) Experiment on FSK demodulation by Multiplying by f_1 or f_2
- (22) Experiment on FM modulation
- (23) Experiment on FM demodulation
- (24) Experiment on digital difference encoding
- (25) Experiment on digital difference decoding
- (26) Experiment on DBPSK modulation
- (27) Experiment on DQPSK modulation

8. Time-Division Multiplexing(TDM)/Pulse-Amplitude Modulation(PAM)(KL-93006)

- (1) Analog-multiplexer modulating experiment
- (2) Analog-multiplexer demodulating experiment
- (3) Analog-multiplexing TDM modulating experiment
- (4) Analog-multiplexing TDM demodulating experiment

9. Frequency Division Multiplexing (KL-93007)

- (1) FDM multiplexer experiment
- (2) BPF characteristics of FDM demultiplexer
- (3) 3-channel FDM demultiplexer experiment

10. Frequency Converter, Carrier Frequency Recovery and Manchester Clock Regeneration (KL-93008)

- (1) Frequency-up and frequency-down experiments
- (2) Carrier frequency recovery experiment
- (3) Manchester encoder / decoder and clock regeneration experiment

● Accessories(KL-98005)

- 1. Connection Leads and Plugs x 1 set
- 2. Storage Cabinet x 2 sets (KL-99001)
- 3. Experiment Manual x 1 pce

Optional Accessories

- 1. Rack Frame (KL-89003)
- 2. Digital Storage Oscilloscope with FFT
- 3. 1GHz Logic Analyzer (16Channel, 200MHz, PC-based)



KL-920

Advanced Digital Communication System



* Notebook, Oscilloscope and Logic analyzer are excluded.

KL-920 is implemented with high speed MCU, DSP and high flexible FPGA devices, giving students more opportunities to setup and observe digital data signals at each transmission stage.

Learning topics include ASK/FSK transmission in wireless ISM band, FEC codec technique (block code and convolution code), digital data formatting (Preamble, ID, FEC and CRC), Manchester coding, SONET transportation frame (STS1 and STM1), TDMA, PCM, TDM, DSSS, CDMA, Digital filter, etc...

● Features

1. Complete digital transmitting data format including start bit, preamble, identifier, data with FEC coding, CRC coding, and stop bit
2. All digital transmitting data are encoded with Manchester code before transmitting via ASK or FSK modulator
3. Programmable data, data rate, preamble, identifier, and noise from DIP switches
4. FEC encoding, CRC mechanism, and Manchester coding can be included or ignored before wireless ISM transmission.
5. Transmit and receive 3 sets of audio signals in TDMA channel via STS1 and STM1 frame
6. Dual channel TDM transmission with audio signal modulated by PCM or A-Law/ μ -Law compander

● Specifications

KL-96001 Main Unit

1. Dual Function Generators

- (1) Output waveform : sine, triangle, square and TTL level signal
- (2) Output voltage
 - a. 1Hz~50KHz : 0~20Vpp, continuously adjustable
 - b. 50KHz~200KHz : 0~16Vpp, continuously adjustable
 - c. 200KHz~500KHz: 0~10Vpp, continuously adjustable
- (3) Output frequency : 6 range, selectable
 - a. 1Hz~10Hz, continuously adjustable
 - b. 10Hz~100Hz, continuously adjustable
 - c. 100Hz~1KHz, continuously adjustable
 - d. 1KHz~10KHz, continuously adjustable
 - e. 10KHz~100KHz, continuously adjustable
 - f. 100KHz~500KHz, continuously adjustable

All above ranges are adjusted by a 10-turn fine tuning knob

- (4) AM modulation signal
 - a. Input amplitude : 0~5Vpp
 - b. Input frequency range : 1Hz~100KHz
 - c. Percentage modulation : 80%
 - d. Output : AM amplitude continuously adjustable
- (5) FM modulation signal
 - a. Input amplitude : 0~5Vpp
 - b. Input Impedance : 10K Ω
 - c. Max. modulation ratio : 50 : 1
- (6) FSK modulation signal
 - a. Input impedance : 10K Ω
 - b. Input \leq 0.7V for low level, adjustable output frequency
Input \geq 3V for high level, fixed output frequency
2. V/F Converter
 - (1) Input voltage : 0~20V
 - (2) Output frequency : 0~20KHz
 - (3) Conversion ratio : 1V = 1KHz
3. Adjustable DC Power Supply
 - (1) Output voltage : 0~20V, continuously adjustable
 - (2) Max. output current : 100mA with overload protection
4. Fixed DC Power Supply
 - (1) Output voltage : +5V, -5V (rated current 500mA)
 - (2) Output voltage : +12V, -12V (rated current 500mA)
5. Universal Frequency/Period Counter
 - (1) Function : logic probe, frequency, period, pulse width
 - (2) Input frequency range (F) : 1Hz~99.999999MHz
10Hz~100.000000MHz
 - (3) Input period range (TH&TL) : 0.01 μ s~999999.99 μ s
1 μ s~99999999 μ s
 - (4) Input level : TTL, analog signal (Vin \geq 2.2Vpp)
 - (5) Sampling time : 1sec & 0.1sec
 - (6) Display : 8-digit, 7-segment display
6. Power Input : AC 90V~230V, 50Hz/60Hz



KL-96021 ISM ASK/FSK Transceiver & Digital Data Encoder

1. RF Carrier
 - (1) Transceiver carrier frequency: 434.92MHz
 - (2) Transmitter carrier power : 10dBm
 - (3) Receiver carrier sensitivity : about -100dBm at 2.4Kbps
 - (4) Modulation : ASK/FSK selectable
 - (5) IF signal : ASK (250KHz), FSK (150KHz)
 - (6) Bandwidth of modulation : 100Hz ~ 16KHz
2. Data Rate
 - (1) 100Hz/62.5Hz
 - (2) 160Hz/100Hz
 - (3) 1.6K/1KHz
 - (4) 16K/10KHz
3. Data Transmission Format
 - (1) Start bit
 - (2) 64-bit encoded data : 8-bit data encoded by 8-bit spread spectrum setting
 - (3) Stop bit
4. Data Transmission
 - (1) Direct modulation
 - (2) Manchester encoding
5. Data Setting and Display :
8-bit data set by high and low key switches and LED display
6. Code Division Encoding and Setting : 8-bit DIP switch

KL-96022 ISM ASK/FSK Transceiver & Digital Data Decoder

1. RF Carrier
 - (1) Transceiver carrier frequency: 434.92MHz
 - (2) Transmitter carrier power : 10dBm
 - (3) Receiver carrier sensitivity : about -100dBm at 2.4Kbps
 - (4) Modulation : ASK/FSK selectable
 - (5) IF signal : ASK (250KHz), FSK (150KHz)
 - (6) Bandwidth of modulation : 100Hz ~ 16KHz
2. Data Rate
 - (1) 100Hz/62.5Hz
 - (2) 160Hz/100Hz
 - (3) 1.6K/1KHz
 - (4) 16K/10KHz
3. Decoder Sampling Frequency: 16X transmitted signal frequency
4. Received Data Decoding Format
 - (1) Start bit check
 - (2) 8-bit spread spectrum code check
 - (3) Stop bit
5. Data Received
 - (1) Direct demodulation
 - (2) Manchester decoding
6. Received Code Division Data Display :
16 LEDs used for 64-bit data display, 16-bit x 4, selected by 2 DIP switches
7. Decoded Data Display : 8 LEDs
8. Code Division Decoding Set : 8-bit DIP switch

KL-96023 ID Code/CRC/FEC (Block Code)/Manchester Data Encoder

1. Data Rate

(1) 100Hz/62.5Hz	(2) 160Hz/100Hz
(3) 1.6K/1KHz	(4) 16K/10KHz
2. Data Setting and Display :
8-bit data set by high and low key switches and LED display
3. 8-bit data Forward Error Correction (FEC) Mode :
Two 16-bit hamming codes
 - (1) 4-bit data + 3-bit error-correcting code, two sets
 - (2) 7-bit data + 4-bit error-correcting code, one set
4. 16-bit Hamming Code Display : 16 LEDs
5. 8-bit ID Code Setting : 8-bit DIP switch
6. CRC Code : CRC-16
7. Data Format : 58-bit data

(1) Start bit	(2) 16-bit preamble code
(3) 8-bit ID	(4) 16-bit FEC hamming code
(5) CRC-16 code	(6) Stop bit

8. Data Transmission
 - (1) Direct modulation
 - (2) Manchester encoding
9. Error Code Setting : 6-bit DIP switch
10. Data Transmission via ISM FSK/ASK Transceiver for RF Remote Data Transfer

KL-96024 ID Code/CRC/FEC (Block Code)/Manchester Data Decoder

1. Data Rate

(1) 100Hz/62.5Hz	(2) 160Hz/100Hz
(3) 1.6K/1KHz	(4) 16K/10KHz
2. 8-bit data Forward Error Correction (FEC) Mode :
two 16-bit hamming codes
 - (1) 4-bit data + 3-bit error-correcting code, two sets
 - (2) 7-bit data + 4-bit error-correcting code, one set
3. FEC Data Display :
8 LEDs for displaying 8-bit or 7-bit correct data received
4. 8-bit ID Code Setting : 8-bit DIP switch
5. CRC Code : CRC-16
6. Data Format : 58-bit data
 - (1) Start bit detecting
 - (2) 16-bit preamble code : detecting signal strength and synchronization
 - (3) 8-bit ID code check
 - (4) 8/7-bit data decoded from 16-bit hamming code
 - (5) CRC-16 code check
 - (6) Stop bit
7. Data Received
 - (1) Direct demodulation
 - (2) Manchester decoding
8. Received Data Display :
16 LEDs for displaying 64-bit receive data (including CRC code)
9. Decoder Output Display : 8 LEDs
10. Decoding Check
 - (1) Flags for ID and CRC checks
 - (2) Hamming code error bits detecting : 6 LEDs
11. Data Transmission via ISM FSK/ASK Transceiver for RF Remote Data Transfer

KL-96025 ID Code/CRC/FEC (Convolution)/Manchester Data Encoder

1. Data Format
 - (1) Start bit
 - (2) 32-bit data or 32-bit data interleave :
16-bit data setting via FEC convolution encoding (1/2 data rate)
 - (3) 8-bit ID code
 - (4) 64-bit data transmission :
40-bit data plus CRC-16 code plus 8-bit ID
2. Error Code Setting and Transmitted Data Monitor
 - (1) Combining 2-bit error byte address with 8-bit error setting for selecting error bits
 - (2) 16 LEDs used for monitoring the transmitted data
3. Transmitted Data can Select Manchester Encoding.
4. Data Transmission via ISM FSK/ASK Transceiver for RF Remote Data Transfer

KL-96026 ID Code/CRC/FEC (Viterbi)/Manchester Data Decoder

1. Data Received
 - (1) Start bit detecting
 - (2) 8-bit ID code check
 - (3) 64-bit data: CRC-16 code calculation and detection
 - (4) 32-bit data interleave setting
 - (5) Viterbi algorithm for decoding correct 16-bit data
2. Manchester Decoding
3. Data Decoding and Receiving LED Display
4. Data Receiving via ISM FSK/ASK Transceiver for RF Remote Data Transfer



KL-96027 ISM FSK/Manchester/ID Code/FEC/CRC Transceiver

1. RF Carrier
 - (1) Transceiver carrier frequency : 433.2MHz
 - (2) Transmitter carrier power : 15dBm
 - (3) Receiver carrier sensitivity : about -105dBm at 100Kbps
 - (4) Modulation : FSK
 - (5) IF signal : 200KHz at 100Kbps
 - (6) Bandwidth of modulation : 1KHz ~ 100KHz
2. Data Transmission Format
 - (1) Programmable preamble : 2bytes or 4bytes
 - (2) Programmable Identifier : 2bytes or 4bytes
 - (3) Programmable data : 1bytes ~ 64bytes
 - (4) FEC Hamming encoding :
 - FEC 4-bit data + 3-bit error-correcting code
 - (5) CRC-16
 - (6) Manchester encoding and decoding
3. Transmission Interface : SPI interface
4. Communicating with PC via SCI Interface

Remark* 1. Experiment module : 2 pcs
2. To carry out more experiment computer is essential but extra.

KL-96028 SONET TDMA-STS1 Multiplexer/Demultiplexer

1. TDMA Modulation and Transmission
 - (1) Speech ADC sampling rate : about 8KHz
 - (2) Speech ADC output : 7-bit
 - (3) Transmission channels : 5
2. Data Input : 5 sets set by five 8-bit DIP switches, 00-7FH (MSB=0), 2 of the five sets can be from DIP switch or ADC
3. Preamble Code : AAAA55H
4. TDMA Transmission Bits : 64-bit
5. TDMA Transmission Rate : about 512.8KHz
6. TDMA Output Signals : STS1 data, frame sync transmit (FSX) and bit sync clock (SYNCLK)
7. TDMA Reception and Demodulation
 - (1) From transmitter output STS1 data
 - (2) Bit clock regeneration
 - (3) Preamble code detect
8. TDMA Demultiplexer Outputs :
 - 3 channels (24-bit, 8-bit each) indicated by LEDs, 2 of the 3 channels can select LED indications or DAC output
9. TDMA Transmission Rate : about 512.8KHz

KL-96029 SONET TDMA-STM1 Data Encoder

1. Speech ADC Sampling Frequency : about 8KHz
2. Speech ADC Output : 7-bit
3. Transmission Channel : 3 sets of STS1 multiplexing transmission
4. Input Data : 7 sets set by seven 8-bit DIP switches, 00-7FH (MSB=0)
5. Preamble Code : AAAA55AA55H
6. TDMA Transmission Bits : 160-bit
7. TDMA Transmission Rate : about 2.105MHz
8. Two STS1 Data Outputs
9. STM1 Data : multiplexed output of three STS1 data inputs

KL-96030 SONET TDMA-STM1 Data Decoder

1. Received STM1 Data
 - (1) Bit clock regeneration
 - (2) Preamble code detect : AAAA55AA55H
 - (3) Demultiplexer STS1 data : 3 sets
2. Demultiplexer Output Display : 7 x 8 LEDs
3. TDMA Transmission Rate : about 2.105MHz

KL-96031 TDM/CODEC; PCM/PWM; DSP-FIR Module

1. TDM-SADC-SDAC-CODEC
 - (1) Codec module : TI TLV320AIC23 chip
 - (2) Stereo TDM (Time Division Multiplexing) signal
 - (3) TDM signal sources
 - a. Internal signal generator : left -sine wave, right -triangle wave
 - b. External line and microphone inputs

2. ADC-PCM-SDAC-PWM

- (1) ADC module
 - a. Resolution : 12-bit
 - b. Max. sampling rate : 2MHz
- (2) PCM (Pulse Code Modulation)
 - a. PCM transmission : SPI bus
 - b. Switch-selected 4-channel inputs
- (3) PCM-SDAC : PCM data to analog signal via SDAC
- (4) PWM (Pulse Width Modulation)
 - PWM resolution : 12-bit
- (5) ADC parallel output and scanned display
 - a. Inputs : 4-channel inputs from ADC outputs
 - b. Outputs : 12-bit parallel TTL-level output, LED indications
 - c. ADC output data display :
 - 4-digit 7-segment LED scanned display

KL-96032 DSSS/CDMA Encoder & Decoder

1. CDMA Encoder
 - (1) CDMA encoder channels : 3 channels
 - (2) Data input of each channel : 8-bit DIP switch setting
 - (3) PN code input of each channel : 8-bit DIP switch setting
 - (4) CDMA encoded sum sequence: 4-bit
2. DSSS Generator
 - (1) Sine, nSine and square wave generator
 - Frequency range : 300Hz ~ 10KHz adjustable, $\pm 20\%$
 - (2) 3-channel DSSS encoder
 - 3 CDMA spread-spectrum signals for BPSK modulation
 - (3) Multi-channel DSSS carrier generator
 - BPSK sum QAM output signal with adjustable gain (Gain value : 1~2)
3. CDMA Decoder
 - (1) PN code : 8-bit DIP switch setting
 - (2) CDMA multiplier output : 5-bit
 - (3) CDMA accumulator output
 - (4) CDMA accumulator sign detecting
 - (5) CDMA decoded data-word output
4. DSSS Decoder
 - (1) Multiplying BPSK sum by PN sequence in DSSS multiplier decoder
 - (2) BPSK sync clock delay adjustment
 - (3) BAPSK (Binary Amplitude Phase Shift Keying) outputs
 - (4) CDMA BAPSK demodulator
 - (5) 5-bit DSSS add-accumulate processing and sign detecting
 - (6) DSSS decoded data-word output

KL-96033 PCM-TDM-Compander Modulation/Demodulation

1. PCM-TDM-Compander (A- μ -Law) Modulation
 - (1) 8-bit ADC module
 - a. Strobe signal : 8KHz
 - b. 4Vpp positive and negative signal levels adjustment
 - c. Input audio frequency : 100Hz ~ 2KHz
 - d. PCM output : 8-bit parallel data PCM to serial TDM output
 - (2) 14-bit μ -Law and 13-bit A-Law audio compression to TDM output
 - a. Switch-selected 14-bit μ -Law or 13-bit A-Law compression
 - b. Converting A- μ -Law input data set by 14-bit DIP switch to 8-bit compressed data
 - c. A- μ -Law compressed 8-bit output indication : 8 LEDs
 - d. A- μ -Law compression rate : at least 1MHz
 - (3) TDM transmitter system
 - a. Operating frequency : 20MHz
 - b. Multiplexer bits: preamble (55AAH) plus 32-bit data
 - c. Bit clock: 434KHz or higher
 - d. Frame Sync Transmit (FSX) frequency : at least 46KHz
 - e. Master/slave setting
 - f. TDM output: TTL-level Q and open-collector NQ
 - g. Connecting two sets of 16-bit data for TDM master/slave multiplexing transmission



2. PCM-TDM-Compander (A- μ -Law) Demodulation

- (1) 8-bit DAC module
 - a. Signal analog output : R-2R buffer and level shifter
 - b. Audio output frequency : 100Hz ~ 2KHz
- (2) 14-bit μ -Law and 13-bit A-Law expanding
 - a. Switch-selected 14-bit μ -Law or 13-bit A-Law audio expanding
 - b. 14/13-bit expanded output indicated by LEDs
- (3) TDM receiver system
 - a. Operating frequency : 20MHz
 - b. Demultiplexer bits : preamble (55AAH) plus 32-bit data
 - c. Bit clock : 434KHz produced by clock regeneration
 - d. Master/slave demultiplexing setting



KL-96001



KL-96021



KL-96022



KL-96023



KL-96024



KL-96025



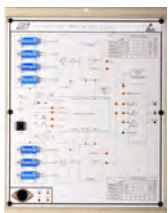
KL-96026



KL-96027



KL-96028



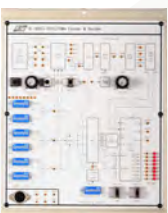
KL-96029



KL-96030



KL-96031



KL-96032



KL-96033

● List of Experiments

1. Data Spread-Spectrum Modulation and Manchester Encoding
2. Serial Data Manchester Encoding/Decoding
3. Spread-Spectrum Data Sampling, Decoding and Checking
4. ASK Digital Data Transmission
5. FSK Digital Data Transmission
6. Data Hamming Encoding and Manchester Encoding
7. Digital Data Decoding and Error Correction
8. Digital Data ASK/FSK Transmission and Decoding
9. Convolutional Encoding and Data Interleaving
10. Viterbi Decoding and Error Correction
11. Viterbi Decoding and FSK Transmission
12. 64-byte Data Transmission
13. 1-byte Data Transmission
14. 1-byte ADC Data Transmission
15. 10-byte ADC Data Transmission
16. PC Digital Data Transmission
17. SONET STS1 Multiplexing
18. SONET STS1 Demultiplexing
19. SONET STM1 Multiplexing
20. SONET STM1 Demultiplexing
21. TDM Codec
22. DSP-Based FIR Filters
23. Multichannel ADC
24. SPI and Serial DAC
25. PWM Modulation
26. CDMA Encoding
27. CDMA Decoding
28. DSSS Encoding
29. DSSS Decoding
30. μ -Law Encoding
31. A-Law Encoding
32. Time Division Multiplexing and Data Compressing
33. Time Division Demultiplexing and Data Expanding

● Accessories(KL-98006)

1. Connection Leads and Plugs x 1 set
2. Storage Cabinet x 2 sets (KL-99001)
3. Experiment Manual x 1 pce

Optional Accessories

1. Rack Frame (KL-89003)
2. Digital Storage Oscilloscope
3. 1GHz Logic Analyzer (16Channel, 200MHz, PC-based)



EMC-100 EMI Training System



* Notebook is excluded

EMC-100 contains two parts. One part is a measurement instrument designed to measure electromagnetic interference (EMI), including conductivity of electromagnetic interference and radiated electromagnetic interference. It provides electromagnetic interference verification on products before inspection. Another part is training modules which allow students to easily implement the experiments and learn the basic concepts of electromagnetic interference and suppression countermeasure. Beginners are able to learn electromagnetic interference theories, measurement and suppression techniques to prepare themselves as being an EMC engineer.

● Features of the hardware and the software

Hardware:

Built-in measurement instrument with a line impedance stabilization network, a spectrum analyzer, and a preamplifier provides electromagnetic interference verification on products before a preliminary inspection. It's a smart and portable device.

Software:

1. Professional laboratory standard measurement with powerful analysis function.
2. Measurement software provides one-shot scan frequency axis displayed in LOG/LIN between 9KHz~30MHz.
3. Peak (PK), Quasi-Peak (QP), Average (Ave) measurement conforming to CISPR 16-1 standard.
4. Spectrum analyzer mode. The peak (PK) measurement performs rapid-scanning. It allows users to make a preliminary inspection and analysis of electromagnetic interference on products.
5. Inspection value can be defined by users, and the data storage capacity can be unlimitedly achieved under PC based mode.

● Features of suppression components

1. Experimental modules are designed for learning electromagnetic interference and suppression countermeasure. More than 50 pieces of suppression components are offered. Moreover, hundreds of suppression experimental modes are introduced in the manual.
2. The suppression components are developed by experienced engineers who are specialized in integration of electromagnetic compatibility. Users can easily learn how to use different suppression components to suppress electromagnetic interference.
3. Plug-in suppression components with error-proofing are expandable and can be easily maintained and modified.
4. A transparent case for clear view of suppression components.

EMC-100 contains the measurement instrument (EMC-11001) providing the electromagnetic interference conductivity, and different experimental modules to support the various radiated experimental courses.

● Specifications

EMI Measurement Instrument (EMC-11001)

1. Input/Output
 - (1) Input voltage : AC 100V~240V, 50Hz/60Hz
 - (2) Output voltage : AC 100V~240V, 50Hz/60Hz
 - (3) Communication interface : USB
2. Line Impedance Stabilization Network (LISN)
 - (1) Frequency range : 9KHz~ 30MHz
 - (2) Characteristic impedance: $(50\mu\text{H}+5\Omega) // 50\Omega$
 - (3) Phase : single-phase
 - (4) Rated current : $2 \times 16\text{A}$
 - (5) Max. AC voltage : 250Vrms
 - (6) Power frequency : DC-63Hz
 - (7) With function of artificial simulative hand
3. Spectrum Analyzer

Frequency Specifications

 - (1) Frequency range : 9KHz~1GHz
 - (2) Counter accuracy : 1Hz + timebase error
 - (3) Frequency resolution : $\leq 100\text{KHz}$
 - (4) Bandwidth resolution : 10Hz~1MHz

Amplitude Specifications

 - (1) Measurement range :
+10dBm to Displayed Average Noise Level (DANL)
 - (2) Noise level average display : -144 dBm/Hz at 1 GHz
 - (3) Max. DC voltage : $\pm 0.2\text{VDC}$

Modulation Analysis

 - (1) Frequency range : 150KHz~300MHz
 - (2) Frequency modulation accuracy : $\pm 1\%$ (typical)
 - (3) Amplitude modulation accuracy : $\pm 1\%$ (typical)
 - (4) Operating temperature : $0^\circ\text{C} \sim +70^\circ\text{C}$ (standard)
4. Preamplifier Specifications
 - (1) Frequency range : 500KHz~1 GHz
 - (2) Gain : 20dB



● EMI Experiment Module Specifications

1. EMC-13001 Conducted Experiment
 - (1) Input voltage : AC 100V~240V, 50Hz/60Hz
 - (2) Producing conduction noise
 - (3) With filter suppression circuit
 - (4) With pluggable suppression components
2. EMC-14001 Radiated Power Supply
 - (1) Input voltage : AC 100V~240V, 50Hz/60Hz
 - (2) Output voltage : DC 12V
 - (3) Output current : 1A
3. EMC-14002 Radiated Case 1
 - (1) Input voltage : DC 12V
 - (2) Producing radiated harmonic noise
 - (3) With π -type filter suppression circuit
 - (4) With pluggable suppression components
 - (5) Circuit board wiring pattern :
horizontal wiring without laying copper
4. EMC-14003 Radiated Case 2
 - (1) Input voltage : DC 12V
 - (2) Producing radiated harmonic noise
 - (3) With π -type filter suppression circuit
 - (4) With pluggable suppression components
 - (5) Circuit board wiring pattern :
vertical orthogonal wiring without laying copper
5. EMC-14004 Radiated Case 3
 - (1) Input voltage : DC 12V
 - (2) Producing radiated harmonic noise
 - (3) With π -type filter suppression circuit
 - (4) With pluggable suppression components
 - (5) Circuit board wiring pattern :
shorted to ground with laying copper
6. EMC-14005 Radiated Case 4
 - (1) Input voltage : DC 12V
 - (2) Producing radiated harmonic noise
 - (3) With π -type filter suppression circuit
 - (4) With pluggable suppression components
 - (5) Circuit board wiring pattern :
simulate two different substrates

Experiment Modules

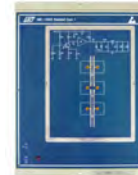
1. EMC-13001 Conducted experiment
2. EMC-14001 Radiated power supply
3. EMC-14002 Radiated Case 1
4. EMC-14003 Radiated Case 2
5. EMC-14004 Radiated Case 3
6. EMC-14005 Radiated Case 4



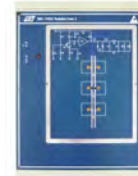
EMC-13001



EMC-14001



EMC-14002



EMC-14003



EMC-14004



EMC-14005

Suppression Components



● List of Experiments

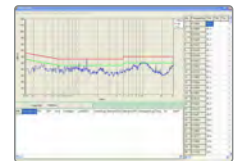
1. Source of waveform for conducted electromagnetic interference
 - 2-1 No Load conduction interference source.....EMC-13001
 - 2-2 Load conduction interference sourceEMC-13001
2. Power supply filtering experiment of conducted electromagnetic interference
 - 3-1 LC Filter circuit.....EMC-13001
 - 3-2 First order filter circuitEMC-13001
 - 3-3 Second order filter circuitEMC-13001
3. Ground experiment of conducted electromagnetic interference
 - A. Filter components without connecting to power grounding experiment
 - 4-1 N-phase conduction measurement.....EMC-13001
 - 4-2 L-phase conduction measurement.....EMC-13001
 - 4-3 First order filter circuitEMC-13001
 - 4-4 Second order filter circuit.....EMC-13001
 - B. Secondary side and power grounding experiment
 - 4-5 N-phase conduction measurement of secondary side grounding experiment.....EMC-13001
 - 4-6 L-phase conduction measurement of secondary side grounding experimentEMC-13001
 - 4-7 First order filter circuit of secondary side grounding experiment.....EMC-13001
 - 4-8 Second order filter circuit of secondary side grounding experimentEMC-13001



4. Optimization experiment of conducted electromagnetic interference
 - 5-1 Filter components choice and filter circuit combinationEMC-13001
 - 5-2 First order filter circuitEMC-13001
 - 5-3 Typical first order filter circuitEMC-13001
 - 5-4 Second order filter circuitEMC-13001
5. Source of waveform for radiated electromagnetic interference
 - 6-1 Interference source experiment of searching for environment and measurement instrument
 - 6-2 Searching for radiated interference source using without laying copper and horizontal wiring circuit moduleEMC-14002
 - 6-3 Searching for radiated interference source using without laying copper and vertical wiring circuit moduleEMC-14003
 - 6-4 Searching for radiated interference source using with laying copper circuit moduleEMC-14004
 - 6-5 Searching for radiated interference source using circuit module of two different substrates simulation...EMC-14005
6. Suppression components experiment of radiated electromagnetic interference
 - 7-1 Radiated interference source measurement...EMC-14002
 - 7-2 Single component suppressionEMC-14002
 - 7-3 Combination components suppressionEMC-14002
 - 7-4 π -type circuit suppressionEMC-14002
 - 7-5 Material selection experiment of suppression componentsEMC-14002
 - 7-6 Ferrite ring and decoupling capacitors experimentEMC-14002
7. Radiated electromagnetic interference grounded experiment
 - 8-1 Circuit to be measured without laying copper (EMC-14003) and ungrounded with laying copper (EMC-14004) of radiated interference source measurement
 - A. Ungrounded experiment with laying copper
 - 8-2 Single component suppressionEMC-14004
 - 8-3 Combination components suppressionEMC-14004
 - 8-4 π -type circuit suppressionEMC-14004
 - B. Grounded experiments of filter suppression components
 - 8-5 Ungrounded with laying copper and grounded with laying copperEMC-14004
 - 8-6 Grounded with laying copper and single component suppressionEMC-14004
 - 8-7 Combination components suppressionEMC-14004
 - 8-8 Grounded with laying copper and π -type circuit suppressionEMC-14004
 8. Shielding experiment of radiated electromagnetic interference
 - A. Shielding experiment
 - 9-1 Shielding experiment without laying copper....EMC-14003
 - 9-2 Shielding experiment with laying copperEMC-14004
 - B. Shielding grounded experiment
 - 9-3 Shielding grounded experiment (including component suppression)EMC-14004
 9. Optimization experiment of radiated electromagnetic interference
 - 10-1 Single component suppressionEMC-14005
 - 10-2 Combination components suppressionEMC-14005
 - 10-3 π -type circuit suppressionEMC-14005
 - 10-4 Grounded experimentEMC-14005
 - 10-5 Shielding experimentEMC-14005

● System Requirements

- PC : CPU i5 2GHz or better
 RAM 4GB or better
 Two USB 2.0 version or better
 Hard disk more than 10GB
 DVD-ROM drive



OS : Win 7/10, 32/64 bit

● Accessories (EMC-19001)

1. Flat Braided Ground Cable x 1 pce
2. Suppression Components x 1 set
3. Storage Cabinet x 1 pce
4. Metallic Board

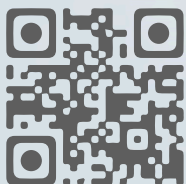
● Consumable Materials

1. Conductive Foam
2. Aluminum Foil Tape

KNOWLEDGE AND HOPE



K&H MFG. CO., LTD.



E-mail: education@kandh.com.tw
Tel: 886-2-2286-0700(Rep.) 886-2-2286-7786
Fax: 886-2-2287-3066, 886-2-2287-9704
5F., No. 8, Sec. 4, Ziqiang Rd., Sanchong Dist,
New Taipei City 241, Taiwan (R.O.C.)
<http://www.kandh.com.tw>

