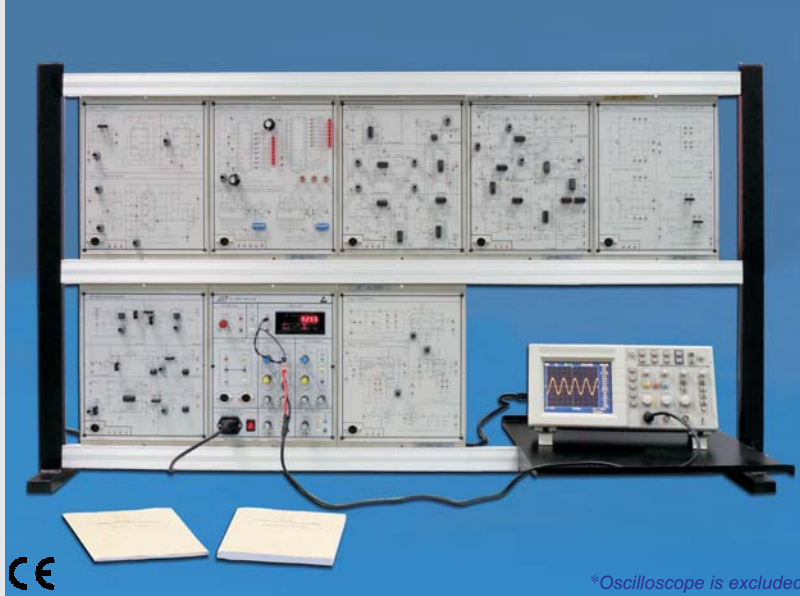




## KL-900A

### Basic Communication System



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

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

#### ► Features

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



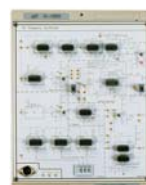
KL-93002



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) Divided 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
    - c. 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
- (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 start frame input
    - e. Auto start frame detector
  - TDM demultiplexer output : Channel A, B, C 3 ports

## 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, ±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, ±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. ±20%, BW : 100KHz, ±10%  
Channel B : 300KHz Adj. ±20%, BW : 100KHz, ±10%

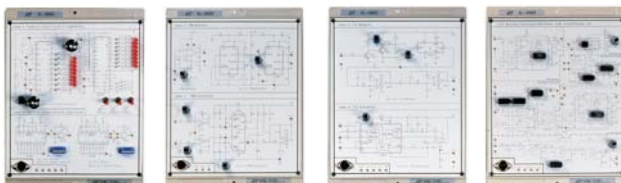


- AM demodulator
  - a. AM rectifier
  - b. Adjust LPF
    - LPF A : Min : 1KHz Adj.  $\pm 20\%$ , Max : 30KHz Adj.  $\pm 20\%$
    - LPF B : Min : 1KHz Adj.  $\pm 20\%$ , Max : 30KHz Adj.  $\pm 20\%$
    - LPF C : Min : 250Hz Adj.  $\pm 20\%$ , Max : 2.5KHz Adj.  $\pm 20\%$
  - c. FDM demultiplexer 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

## 9. KL-94001 A/D, D/A Converter Applications

- (1) Analog to digital converter
  - a. Resolution : 8 bits 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 bits
  - b. Output voltage type : Single or bipolar
  - c. Power supply : +12V, -12V

## 10. 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

## 11. 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

## 12. 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

## 13. 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

## 14. KL-94006 PSK/QPSK Modulator

- (1) PSK/QPSK Modulator
  - Production & measurement of data stream of QPSK
    - a. Data speed : 400bps ~ 1000bps
  - QPSK modulator
    - a. Carrier signal : 7KHz



## 15.KL-94007 PSK/QPSK Demodulator

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

## 16.KL-96001 Main Unit



KL-96001

- (1) Dual function generators
  - Output waveform : Sine, Triangle, Square and TTL level signal
  - Output voltage
    - a. 1 Hz~50 KHz : 0~20Vpp continuously adjustable
    - b. 50 KHz~200 KHz : 0~16Vpp continuously adjustable
    - c. 200 KHz~500 KHz : 0~10Vpp continuously adjustable
  - Output frequency : 6 Ranges, selectable
    - a. 1 Hz~10 Hz continuously adjustable
    - b. 10 Hz~100Hz continuously adjustable
    - c. 100Hz~1 KHz continuously adjustable
    - d. 1 KHz~10 KHz continuously adjustable
    - e. 10 KHz~100 KHz continuously adjustable
    - f. 100 KHz~500 KHz continuously adjustable
 All above ranges are adjusted by a 10-turn fine tuning knob
  - AM modulation input
    - a. Input amplitude : 0~5Vpp
    - b. Input frequency range : 1 Hz~100 KHz
    - c. Percentage modulation : 80%
    - d. Output : AM amplitude continuously adjustable
  - FM modulation input
    - a. Input amplitude : 0~5Vpp
    - b. Input Impedance : 10 K $\Omega$
    - c. Maximum modulation ratio : 50:1
  - FSK modulation input
    - a. Input impedance : 10 K $\Omega$
    - 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 : 0~20 KHz
  - Conversion ratio : 1 V = 1 KHz
- (3) Adjustable DC power supply
  - Output voltage : 0~20 V continuously adjustable
  - Maximum output current : 100 mA with overload protection
- (4) Fixed DC power supply
  - Output voltage : +5 V, -5V (rated current 500 mA)
  - Output voltage : +12V, -12V (rated current 300 mA)
- (5) Universal frequency/period counter
  - Function : Logic Probe/Frequency/Period/Pulse Width
  - Input frequency range (F) : 1 Hz~99.999999 MHz  
10 Hz~100.000000 MHz
  - Input period range (TH&TL): 0.01  $\mu$ s~999999.99  $\mu$ s  
1  $\mu$ s~99999999  $\mu$ 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

## ► 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. PLL frequency synthesizer
10. TDM multiplexer experiments
11. TDM demultiplexer experiments
12. FDM multiplexer experiments
13. FDM demultiplexer experiments
14. Multiplier frequency up/down converter experiment
15. Carrier frequency recovery experiment
16. Synchronous clock recovery 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

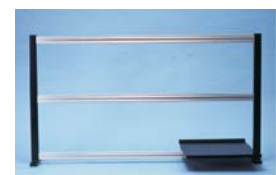
1. Connector leads : 1 set
2. Experiment manual : 1 pce
3. Teacher's guide : 1 pce
4. Storage cabinet : 2 sets (KL-99001)

### Optional Accessories

1. Rack frame (KL-97001)
2. RF generator (KI-2220)
3. Digital storage oscilloscope with FFT



Storage cabinet (KL-99001)



Option : Rack frame. (KL-97001)



Option : KI-2220 150MHz RF generator