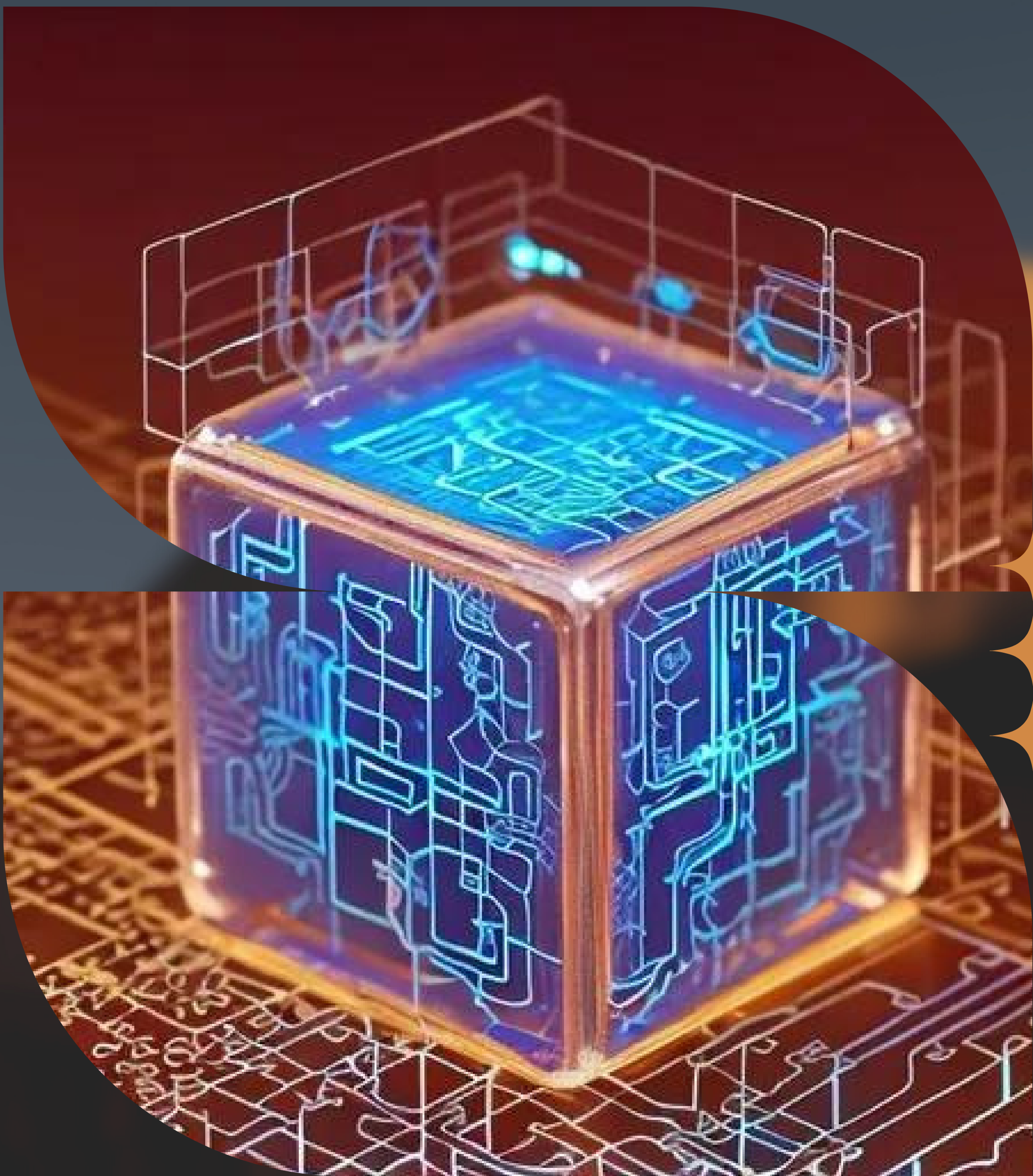
Product CATALOG

2023



TECHNO INSTRUMENTS

About us

Study of Automatic Control System forms an integral part of the engineering education in the disciplines of Electrical, Telecommunication, Electronics, Mechanical, Industrial and Chemical Engineering. Actual industrial control systems being complex, bulky and expensive, are not suitable for classroom training purposes. Realising the need for laboratory support in Control Engineering and Instrumentation area, Techno Instruments for the last 18 years, has been developing working laboratory models and simulated systems specially suitable to the laboratory environments in Engineering Institutions. Our range of items does not include virtual instrumentation and virtual experimentation wherein all tasks are performed on a PC through special purpose software. It is our firm belief that engineering expertise can be gained by actual interaction with physical systems, which should be readily available to every student. All our systems are therefore inexpensive, laboratory oriented fully backed by exhaustive theoretical treatment, experimental details, typical results and references.

The Catalogue presents a brief description of the systems currently being offered. A detailed literature is supplied with the units. Custom built products are also developed to suit the special requirements. It has been our policy to review and improve the equipment manuals on a continual basis. We therefore welcome user feedback in any form, which goes a long way towards perfection.

Warranty

All our products are manufactured under high level of quality control. They are warranted free from defects for a period of one year from the date of purchase. We will repair or replace as find suitable, any piece of defective equipment during this period. Even after this period after sales service is undertaken at very nominal charges.

Specifications

Specifications of all products are subject to change without notice. Techno Instruments reserves the right to make improvements to the products without incurring any obligation to incorporate these changes in products previously sold.

Power requirement

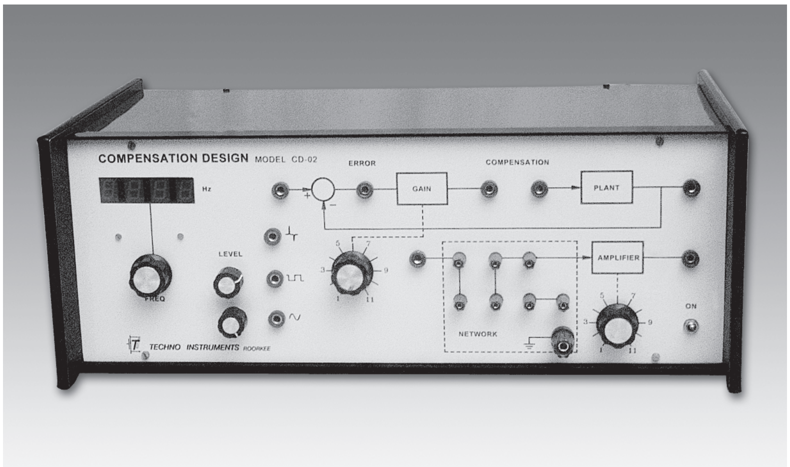
Equipment in this catalogue are designed to operate from 220V ±10%, 50Hz. All the equipment are also available for use with 110V ±10%, 60Hz power at no additional cost.

Index

Techno Instruments

COMPENSATION DESIGN CD-02

- **Design and test cascade compensator**
- **Simulated system for accurate results**
- **Built-in compensator gain – only passive external components needed**
- **Built-in signal sources**



Introduction

Practical feedback control systems are often required to satisfy design specifications in the transient as well as steady state regions. This is usually not possible by selecting good quality components alone, due to basic physical limitations and characteristics of these components. Cascade compensation is most commonly used for this purpose and the design of compensation networks figures prominently in any course on automatic control systems. Due to the absence of any laboratory experience, however, the concepts of compensation remain rather vague. This unit has been designed to enable the students to go through the complete design procedure and finally verify the performance improvements provided by compensation.

A simulated second order system with variable gain is taken as the 'unsatisfactory system'. Simulated system has the advantage of predictable performance which is necessary if the verification of the results is to be meaningful. Built-in variable frquency square wave and sine wave generators are provided for time domain and frequency domain testing of the system. The frequency may be varied in the range 25Hz – 800Hz and its value read on a built-in frequency meter on the panel. Although most practical control systems have bandwidth upto a few Hz only, a higher bandwidth has been chosen for the simulated system to facilitate viewing on a CRO. A pre-wired amplifier makes the implementation of the compensation network extremely simple. Only a few passive components need plugging into the circuit. Lead and lag networks may be designed and tested on the set-up using both frequency domain and s-plane procedures.

The experimental set-up is accompanied by the supporting literature which becomes of vital importance as a major part of the experiment involves theoretical design of compensation networks. Although a complete coverage of design philosophy is not feasible in this document, all efforts have been made to describe the salient features and design steps of the four problems listed above. Also included is a typical design, explicitly covered with compensation network parameter calculation and final results.

Experiments

- Lag compensation in the frequency domain
- Lead compensation in the frequency domain
- Lag compensation in the s-plane
- Lead compensation in the s-plane

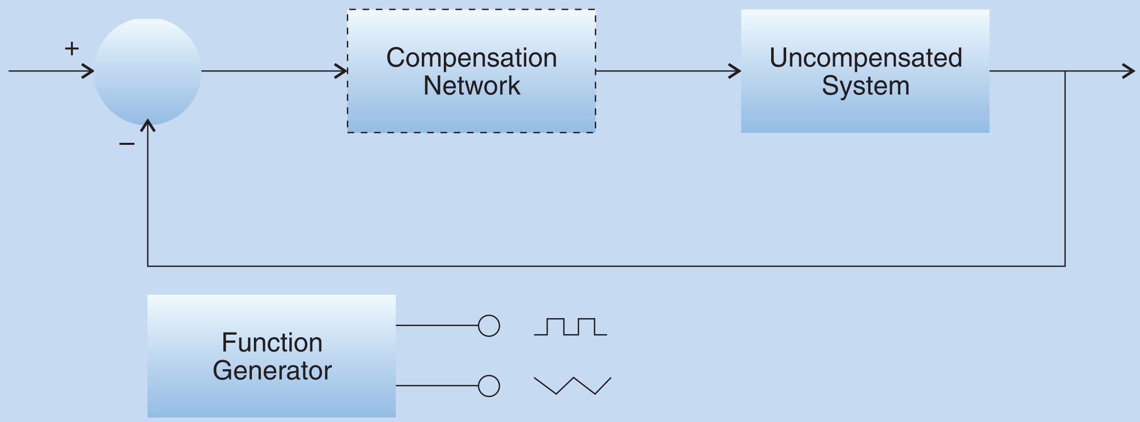
To start with, a suitable 'uncompensated system' is chosen, either by an arbitrary setting of the gain control potentiometer or by setting it to result in a given value of overshoot as seen by step response test. Next a set of specifications - both transient and steady state - are prescribed as an objective by the teacher. The design may then be carried out by one of the above techniques and the results verified by a step response or frequency response testing

All the above design problems may be undertaken for a very wide range of design specifications. Notice that the implementation of the compensation network has been made very convenient by a prewired amplifier with calibrated gain.

Features and Specifications

- Simulated 'uncompensated' system having adjustable damping. Peak percent overshoot M_P, variable from 20% to 50%, and steady state error variables from 50% to 0.5%
- Compensation network implementation through built-in variable gain amplifier. Gain is adjustable from 1 to 11
- Built-in square and sine wave generators for transient and frequency response studies. Frequency adjustable from 25Hz – 800Hz (approx.)
- 220V±10%, 50Hz mains operation
- Complete in all respects, except a measuring CRO

Schematic Diagram



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A.C. SERVOMOTOR STUDY

ACS-01

- **Torque computation through electrical loading**
- **Determination of motor para-meters - inertia and friction**
- **Digital display of time constant**
- **Transfer function evaluation**

Introduction

Two phase a.c. servomotor is one of the very important electromechanical actuators having applications in the area of control systems. The study of its operating principle and features form a part of the first course on automatic control systems in electrical engineering curriculum. It's small size, low inertia and almost noise and frictionless operation makes the a.c. servomotor particularly attractive in aircraft and spacecraft applications.

The characteristics of an a.c. motor is usually non-linear. To simplify the analysis a linearized model is developed. The experimental work revolves around determination of the parameters of the motor and thus its transfer function.

Important subsystems of the unit includes:

- an integrated speed sensor with 4-digit display in r.p.m.
- an electrical loading system to compute torque
- a time-constant measurement circuit with 3-digit display in milli seconds
- a three step a.c. source with built-in rms voltmeter, and
- a digital voltmeter on the panel for load measurement

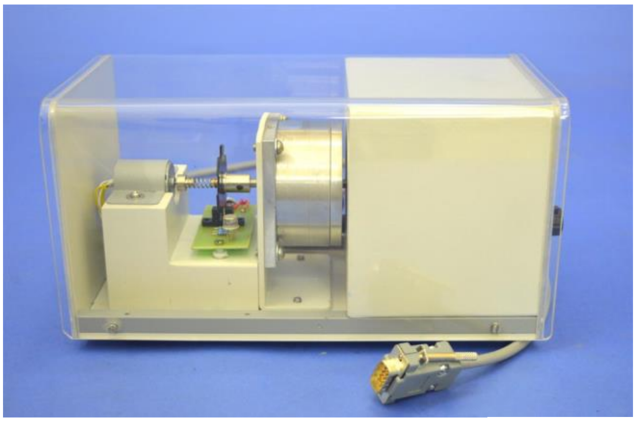
The unit has been designed such that expensive equipment like storage CRO is not needed. Also the hassle of direct torque measurement using spring balance etc. is avoided by linearization of the motor characteristics analytically.

Experiments

- Inertia and friction parameters
- Time constant
- Transfer function

Features and Specifications

- 2-phase a.c. servomotor - 12V/ 50Hz per phase
- Small generator for loading
- 4-digit speed display
- 3-digit time constant display
- 3½ digit r.m.s. voltmeter
- 3½ digit d.c. panel meter
- Voltage regulated internal supplies



Motor Unit

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AC MOTOR TORQUE SPEED

ACT-01

- **Torque-speed characteristics by mechanical loading**
- **Calculation of mechanical power output at various speeds**

Introduction

AC Servomotors are useful in a large range of control applications at low power levels. These are basically 2-phase squirrel cage induction motors with a high resistance rotor. A basic advantage of these motors is their small size and free movement due to the absence of any commutator and brushes as in dc motors.

The present unit is designed to study the torque-speed characteristics of the motor by mechanically loading it with the help of an adjustable friction grip and recording the torque in terms of the force exerted on a load cell. Load cell output is then processed by a well-designed instrumentation amplifier and displayed in gm-cm. Shaft speed of the motor is picked up by a slotted disc/opto-interrupter pair and displayed in rpm.

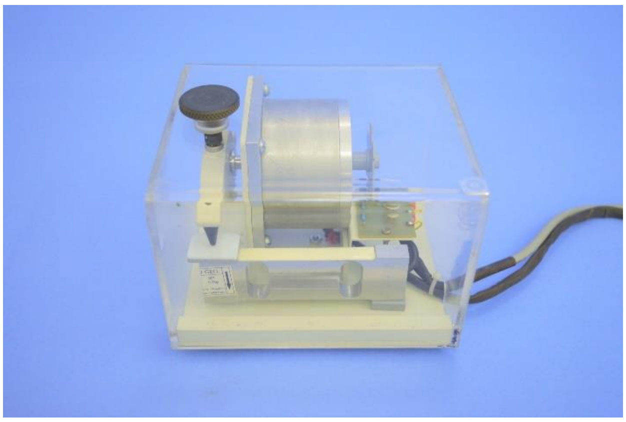
Main unit has all the necessary circuits and meters while the motor unit, housed in a transparent box, displays the mechanical arrangements.

Experiments

- Torque-speed characteristics by mechanical loading
- Electrical power input at various loads
- Torque constant, speed regulation and efficiency determination

Features and Specifications

- Study of a 12V, 0.5A permanent magnet dc motor
- Friction grip type (Prony Brake) adjustable loading arrangement
- Load cell based force measurement with 3-digit display
- 4-digit speed display in rpm
- Volt/Ampere motor power readout on DPM
- Supporting user manual with all details of the experiment
- Compact unit with no additional accessories required



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D.C. MOTOR STUDY

DCM-01

- **Torque-speed characteristics**
- **Determination of motor parameters - inertia and friction**
- **Digital display of time constant**
- **Transfer function evaluation**

Introduction

A d.c. motor is commonly used as an actuator in many industrial control applications because of its features - large torque and ease of speed variation. The dynamic characteristics of such a system therefore depends on the motor parameters viz., moment of inertia, coefficient of friction, time constant and also the resistance and inductance of the control winding. It is therefore important to experimentally determine the mechanical and electrical parameters of the d.c. motor and also to evaluate its transfer function.

The present unit is designed to study a small permanent magnet d.c. motor. A still smaller generator directly coupled to the motor is used for the dual purposes of speed signal pick up and providing electrical loading. The shaft speed in rpm is displayed automatically on a 4-digit panel meter.

When the motor is suddenly switched ON a novel circuit computes and displays the time constant in milliseconds on a 3-digit panel meter. This avoids the need for an expensive storage CRO. The motor unit is housed in a cabinet with transparent panels, providing a good view of the mechanical system.

Experiments

- Determination of torque-speed characteristics
- Determination of inertia and friction parameters
- Determination of back e.m.f. constant
- Determination of time constant
- Determination of transfer function

Features and Specifications

- Study of a 12V, 8W d.c. motor
- Small generator (2W) for speed pick up and loading
- 4-digit speed display
- 3-digit time constant display
- 3½ digit voltmeter and current meter for d.c. measurement
- IC regulated power supply
- Supporting literature with experiment details

Motor Unit

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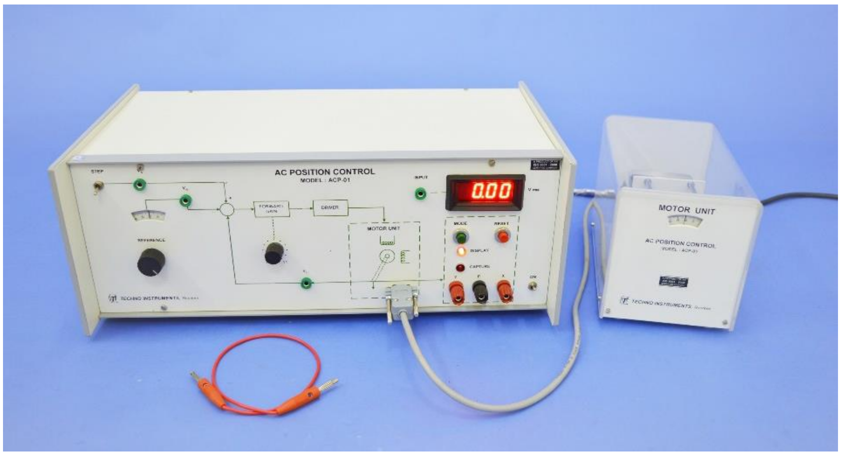
A.C. POSITION CONTROL

ACP-01

- **2-phase A.C. Servomotor**
- **Servo Potentiometer for position sensing**
- **Transient response capture/display**
- **In-built rms voltmeter on panel**



Introduction

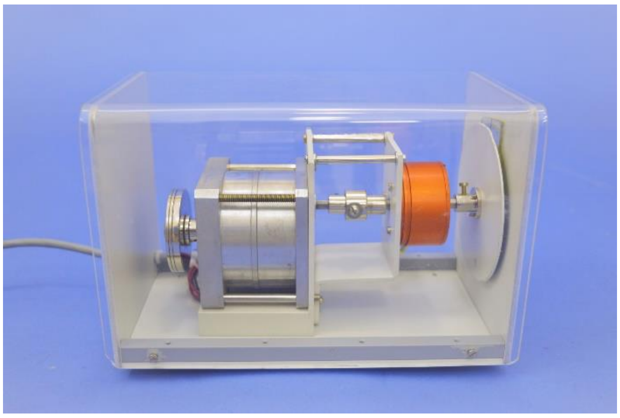
2-phase ac servomotors have been traditionally used for position/speed control applications especially in light weight, precision instrumentation area in airborne systems. These motors, though more expensive than industry standard split-phase induction motors and ac driven stepper motors, have a much better torque-speed characteristics. (Additional information may be found in our experiment entitled 'Study of AC Servomotor, Model:ACS-01).

The present unit is designed around a 12 V ac servomotor and exposes the basic characteristics and dynamics of a position control system. A block diagram of the system is shown in Fig. 1. It may be observed that the error detector consists of two servo potentiometers rather than a synchro pair. This is done primarily to limit the cost of the unit to make it affordable to the target market-educational institutions in the country. This variation does not in any way compromise the performance of the unit or the knowledge gained by the students.

Besides introducing the basic features like balanced modulation of the error signal, phase reversal around the set point and phase difference between the reference and control phases of the motor, the experiment involves study of the step response of the closed loop system. Being a mechanical system the response is too slow for a comfortable viewing on a CRO, except on an expensive storage oscilloscope. A microprocessor based waveform capture/ display card in the unit stores the step response in real time and displays the same once steady state is reached.

Experiments

- Error detector characteristics, phase reversal
- Amplifier gain measurement
- Phase difference between control and reference windings
- Step response study



Features and Specifications

- 2-phase servomotor – 12 volt/phase, 50Hz, 10 watt
- Power amplifier for driving
- Servo potentiometer type error detector
- In-built 10.00 volt (rms) panel meter
- Step response capture/display card
- Detailed literature with typical results included
- Complete unit except a measuring CRO
- 220 volts, 50 Hz mains operation

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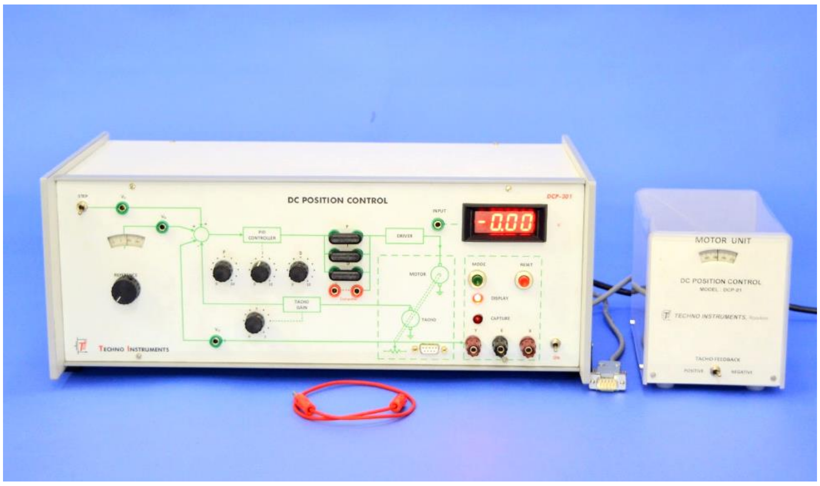
D.C. POSITION CONTROL

DCP-301

- **Compact system - no mechanical hassles**
- **Simplified operation with independent P, I and D controls**
- **µP based storage of response**
- **Positive/Negative tachogenerator feedback**
- **Standalone or MATLAB interfaced operation possible**



Introduction

One of the most common examples covered in text books and literature on linear systems is a d.c. position control system. This system is easily understood and has a second order transfer function in the standard form, for which a well developed theoretical treatment is available.

This unit provides the students an opportunity to study and operate a practical electromechanical angular-position-control system. The system is built around a good quality permanent magnet armature-controlled d.c. motor, speed reduction gear-set, potentiometric error detector using special 360° revolution servo potentiometers, a tachogenerator for velocity feedback and associated electronic circuits. A PID controller with adjustable parameters is included. Unlike simulated systems, e.g. our LINEAR SYSTEM SIMULATOR, the position control system naturally consists of non-ideal parameters viz. saturation of amplifier and motor current, dead zone and backlash, non- linearity in the motor and gears, imperfections in mechanical fabrication and somewhat uncertain order of the complete system due to filters, various time constants and load parameters. Experimental work on this system would enable the students to appreciate the difference in performance between idealized systems studied in the theory classes and the systems encountered in practice.

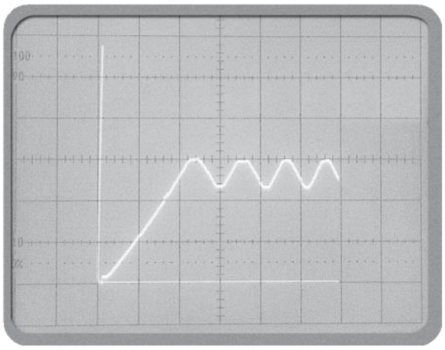
A difficulty which is faced while working with many practical control systems is that their responses are rather slow (Note that in a simulated system the common practice is to scale-up the frequency to ensure a proper viewing on a CRO). A storage CRO or an X-Y plotter is therefore required for studying the waveforms. Both these instruments are too expensive and/or delicate, and are therefore not usually available to the undergraduate students in most institutions. The present unit has a built-in µP based waveform capture/display system which stores the step response of the control system in a RAM and then displays it on a measuring CRO for further studies. This arrangement is extremely simple to operate and conforms to the accuracy needs of a class room experiment.

The motor unit is housed in a separate cabinet with transparent panels for easy viewing. Interconnection with the main unit is through a standard 9-pin D-type connector. All power supplies and step input signal are internally provided. In addition a 3½ digit DVM is available on the panel for the measurement of various signals. A good quality measuring CRO is the only accessory that would be required.

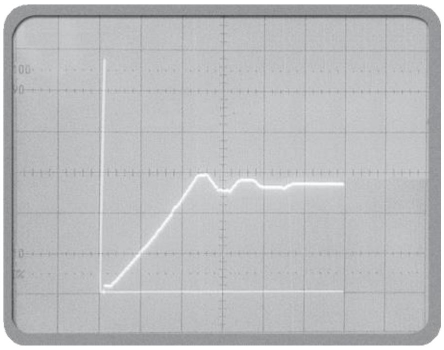
Experiments

- Operation of the position control system for different values of the forward gain to angular position commands
- Step response studies for various values of forward gain
- Study of the effect of velocity feedback on the transient and steady state performance of the system as well as its stability
- Design and implement a PID controller, in hardware or MATLAB and study its performance

The experiments would involve calibration and operation of the waveform capture/display section as a first step. It may be mentioned here that due to the non-linearities and other imperfections and uncertainties existing in a physical system of the present type, a quantitative verification of the results with theoretical analysis is not recommended. This is best done on a simulated system. Of course the experimental work does include determination of rise time, overshoot, steady state errors etc. for various conditions for an evaluation of the system performance.



Oscillatory response

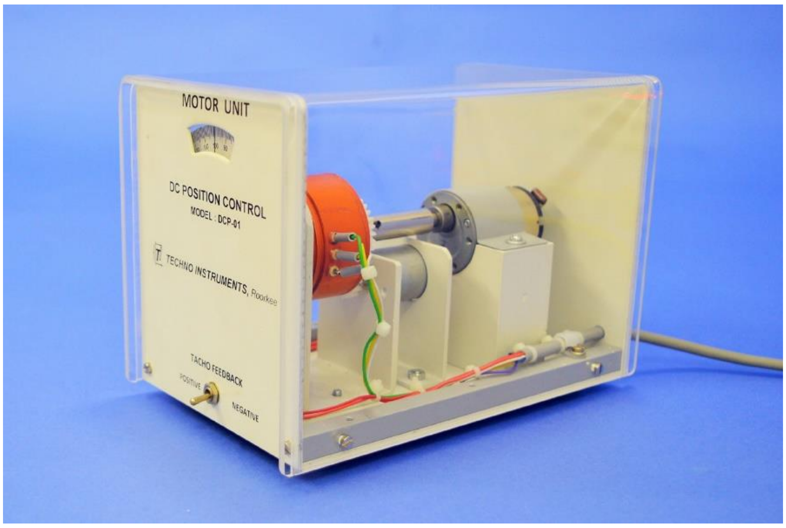


Underdamped response

Features and Specifications

- Position control of a 12V, 1A d.c. gear motor (50 rpm)
- Provision for positive and negative tachogenerator feedback

  Tacho constant: 2V/1000 rpm approximately
- Calibrated dials for reference and output position: resolution 1°
- Servo-potentiometers with full 360° rotation
- μP based waveform capture/display card
- MATLAB interface provided
- Built-in 3½ digit DVM for signal measurements
- Built-in step signal and IC regulated power supplies for electronic circuits
- Separate unit for motor in a see-through cabinet
- 220V±10%, 50Hz mains operation
- Literature and patch cords included
- Essential accessories - a CRO

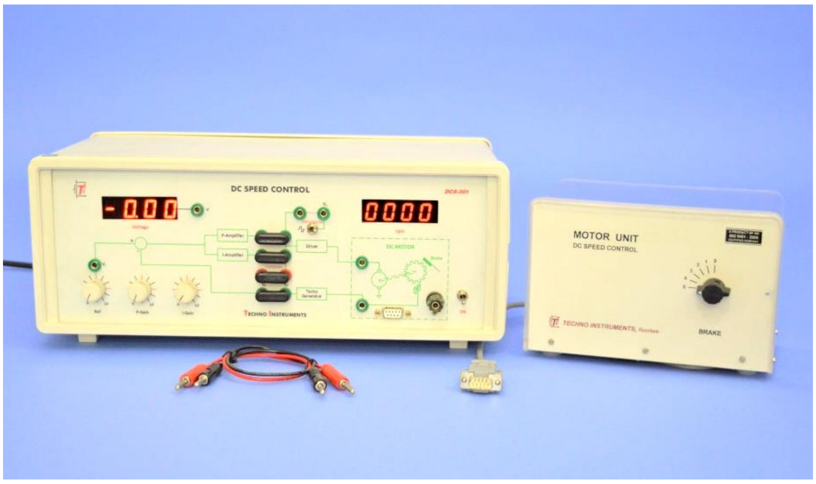


Motor Unit

D.C. SPEED CONTROL SYSTEM

DCS-301

- **Closed loop motor speed control with eddy current brake**
- **Built-in PI Controller**
- **Compact system-no mechanical hassles**
- **Opto electronic speed sensor**
- **Digital display of speed on the panel**
- **MATLAB interface provided for computer control**



Introduction

Accurate speed control is a requirement in many industrial and process control systems. The main characteristics of such a system are its steady state error and disturbance rejection properties. Speed control of a d.c. motor is also one of the basic systems covered in a first course on automatic control system. The present unit, built around a small permanent magnet d.c. motor, is designed to bring out the salient features of such a system. Facilities are available to directly measure the principal performance factors of the speed control system, viz., steady state error and load disturbance rejection, as a function of the forward path gain. In addition, the experimental work involves the determination of the motor transfer function and the characteristics of the tachogenerator. A built-in PI-controller having adjustable parameters can be set to minimize the steady state error. This design may also be done in the MATLAB environment.

An important feature of the unit is the built-in absolute speed measurement through optical pick-up from a slotted disk followed by a frequency counter. The 4-digit speed display is therefore completely independent of the tachogenerator characteristics. The high accuracy of speed reading is due to a built-in crystal oscillator. Another interesting design feature is the use of an 'electronic tachogenerator' - a frequency to voltage converter, for the generation of speed feedback signal. This highly linear, non-contact transducer is ideally suited for the small d.c. motor being used in the unit.

Variable loading of the motor is achieved by a built-in eddy current brake. This brake has superior characteristics compared to friction brake especially for a small motor. The motor unit, housed in a cabinet with transparent panels, provides a good view of the mechanical arrangements.

In addition, a 3½ digit DVM is available on the panel for the measurement of various d.c. signals. A measuring CRO is the only accessory that will be required for conducting the experiments.

Experiments

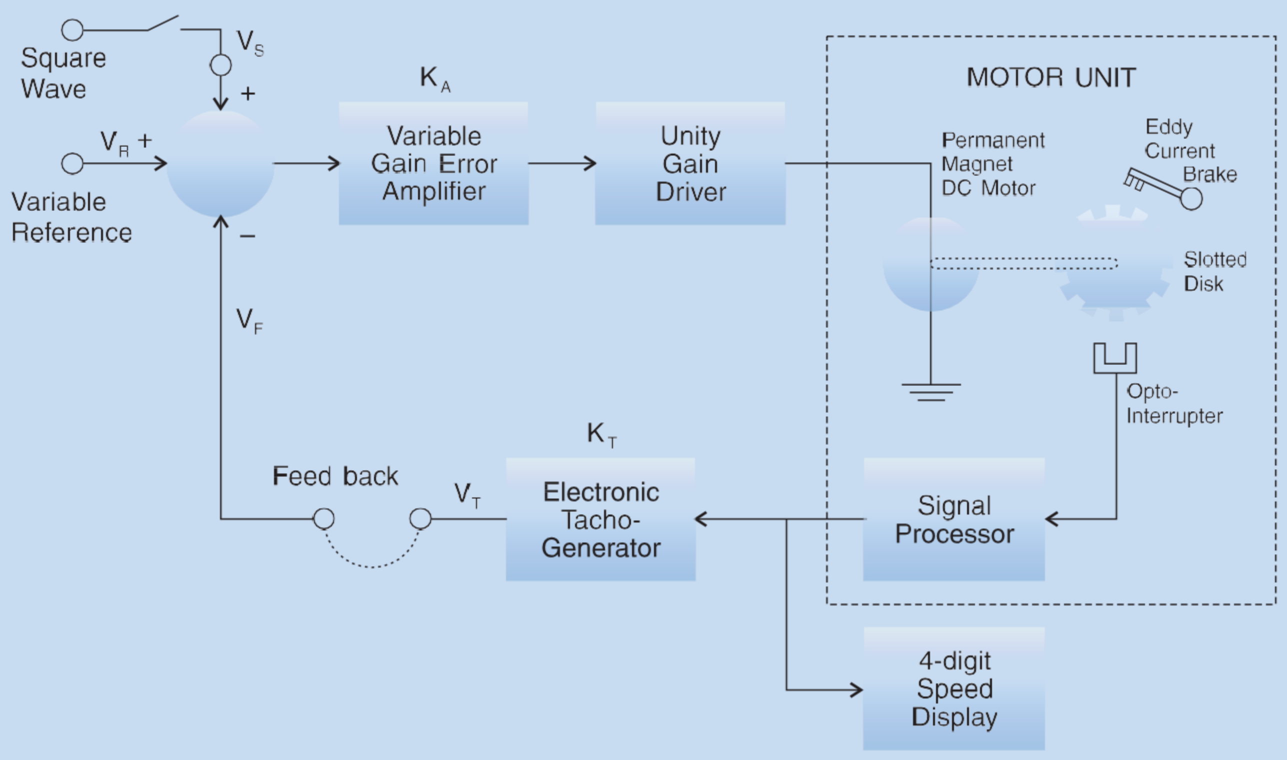
- Effect of loading on the speed of the motor in the open loop
- Steady state error variation with forward gain
- Effect of I-control on the steady state error
- System time constant variation with forward gain
- Effect of forward gain on disturbance rejection
- Determination of the motor transfer function and tachometer characteristics
- Controller design in the MATLAB environment

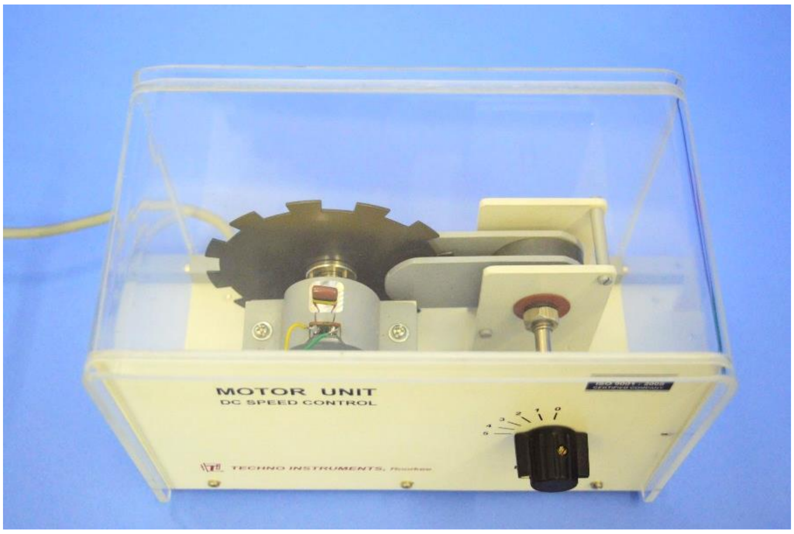
Features and Specifications

- Speed control of a 12V, 4W permanent magnet d.c. motor
- Speed range : 0 to 3000 rpm (typical)
- Opto-interrupter based speed sensing
- 4-digit speed display in rpm
- Electronic tachogenerator for feedback
- Separate unit for motor in a see-through cabinet
- Smooth, non-contact eddy current brake for loading

- Built-in 3½ digit DVM for signal measurements
- Built-in IC regulated internal power supply
- 220V±10%, 50Hz mains operation
- Supporting literature and patch cords included
- Essential accessory – a CRO

Schematic Diagram





Motor unit

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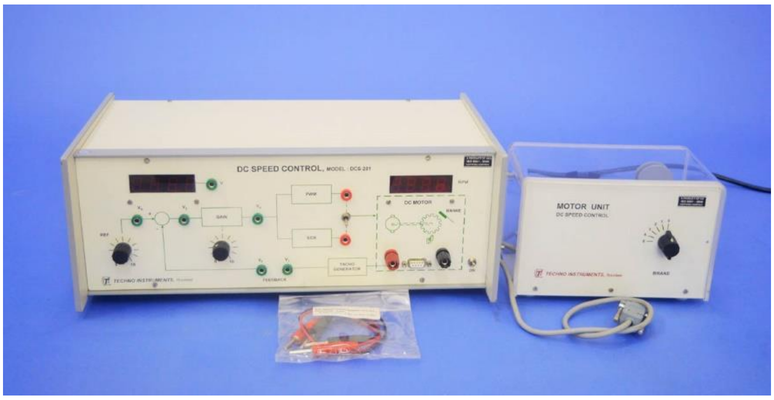
D.C. SPEED CONTROL SYSTEM

DCS-201

- **PWM Power Control**
- **SCR Power Control**
- **CRO Display of Waveforms**
- **4-Digit Speed Display in rpm**
- **Contactless Eddy Current Braking**



Introduction

Closed loop speed control of dc motor is a common experiment for studying various features of automatic control systems like control, regulation and disturbance rejection. The present unit is designed to demonstrate the working of PWM and SCR based controllers and show the resulting waveforms of the voltage supplied to the motor. Measurement of the timings on the waveforms under various conditions has been suggested to get a good insight into the operation of the system. The experiment is complete with all the sub-systems and a detailed operating literature is included which introduces the basic theory, suggested experiments and an interpretation of the results. An external CRO is all that is needed to view the waveforms and measure the timings.

Experiments

- Open loop speed control for PWM Controller, with and without load
- Open loop speed control for SCR Controller, with and without load
- Closed loop speed control for PWM Controller with load
- Closed loop speed control for SCR Controller with load
- Observation and measurements on the voltage waveforms

Features and Specifications

- Speed control of a 12V, 4W
- permanent magnet d.c. motor
- Speed range : 0 to 3000 rpm (typical)
- Opto-interrupter based speed sensing
- 4-digit speed display in rpm
- Electronic tachogenerator for feedback
- Separate unit for motor in a see-through cabinet
- Smooth, non-contact eddy current brake for loading
- Built-in 3½ digit DVM for signal measurements
- Built-in IC regulated internal power supply
- 220V±10%, 50Hz mains operation.

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DC MOTOR TORQUE SPEED

DCT-01

- **Torque-speed characteristics by mechanical loading**
- **Torque vs motor current plot**
- **Evaluation of torque constant**
- **Calculation of overall and mechanical efficiencies**
- **Speed regulation computation**

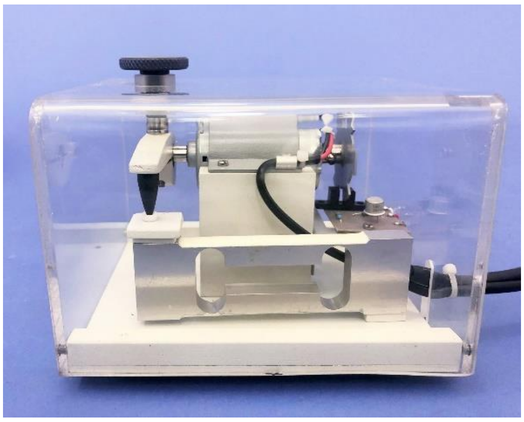
Introduction

Permanent magnet dc motors are useful in a large range of applications at small and medium power levels. Their main application area is in battery operated systems like in automobiles, electric vehicles, portable drives and tools and a number of articles of daily use. A basic advantage of these motors is their small size and greater efficiency due to the absence of any field power requirement.

The present unit is designed to study the torque-speed characteristics of the motor by mechanically loading it with the help of an adjustable friction grip and recording the torque in terms of the force exerted on a load cell. Load cell output is then processed by a well-designed instrumentation amplifier and displayed in gm-cm. Shaft speed of the motor is picked up by a slotted disc/opto-interrupter pair and displayed in rpm.

Main unit has all the necessary circuits and meters while the motor unit, housed in a transparent box, displays the mechanical arrangements..

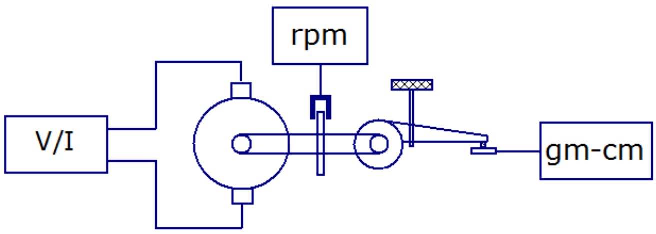
Experiments



- Torque-speed characteristics by mechanical loading
- Electrical power input at various loads
- Torque constant, speed regulation and efficiency determination

Features and Specifications

- Study of a 12V, 0.5A permanent magnet dc motor
- Friction grip type (Prony Brake) adjustable loading arrangement
- Load cell based force measurement with 3-digit display
- 4-digit speed display in rpm
- Volt/Ampere motor power readout on DPM
- Supporting user manual with all details of the experiment
- Compact unit with no additional accessories required



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STUDY OF SYNCHRO DEVICES

SD-01

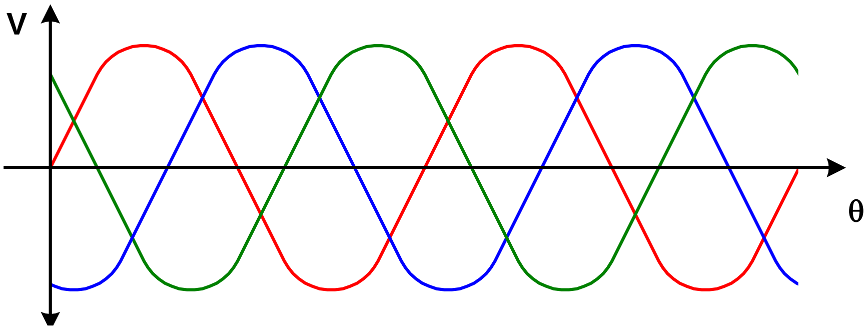
- **Synchro transmitter-receiver pair with calibrated dials**
- **Locking system for receiver rotor**
- **Receiver use as control transformer**
- **Built-in balanced demodulator circuit**
- **Panel meter for ac/dc voltages**
- **All internal power from the 220V/50 Hz mains**
- **Only an external CRO required**

Experiments

- Basic characteristics study - stator voltages as a function of the rotor angle using the built-in ac voltmeter. This shows the space variation of the three voltages, V_{S1S2}, V_{S2S3}, and V_{S3S1}, causing rotation of the resultant magnetization in the stator which is fundamental to the error detection process.
- Operation and error study of the transmitter-receiver pair as a simple open loop position control at a very low torque. This is a rarely used application but is used to demonstrate the direction of the resultant magnetic field in the receiver.
- Plotting the error voltage output as a function of the transmitter rotor angle with the receiver rotor locked. Observing the 180° phase reversal around the zero error is significant as this the basic method through which the direction of the error is detected in an ac system
- Use of balanced demodulator to develop dc error signal with appropriate polarity and compare it with the ac error. This block would be needed if a mixed system were to be designed using both dc and ac components.

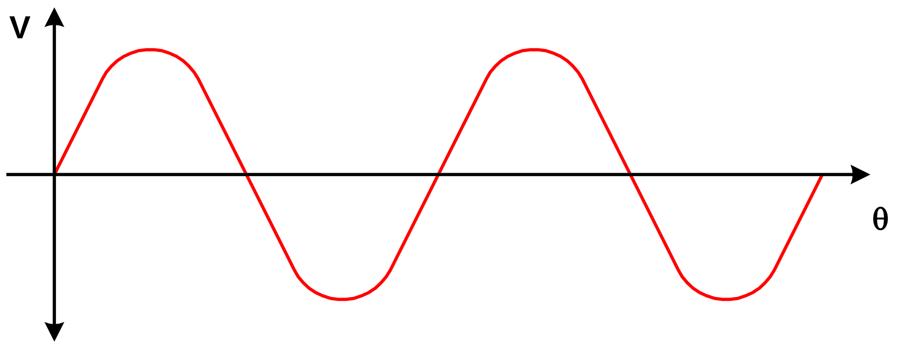
Typical Results

- The plot of the three stator voltages, VS1S2, VS2S3, and VS3S1 as a function of rotor angle are usually shown as



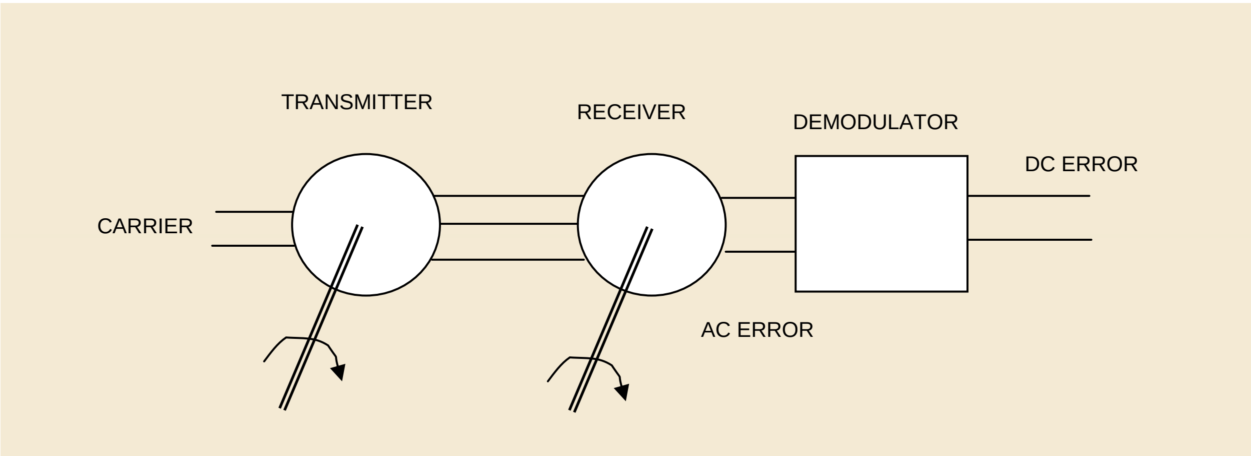
It should be of interest to visualize why the ac voltages are also plotted as negative values!

- The error voltage plot is of the form as under

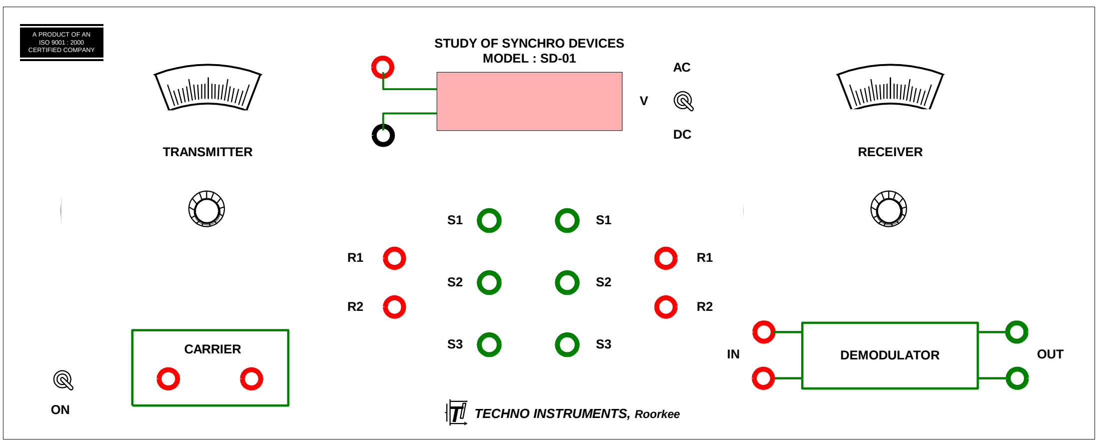


Observe that the input-output characteristics of the synchro error detector is distinctly non-linear. How is it used in a linear system should be of interest.

Schematic Diagram



Panel Diagram



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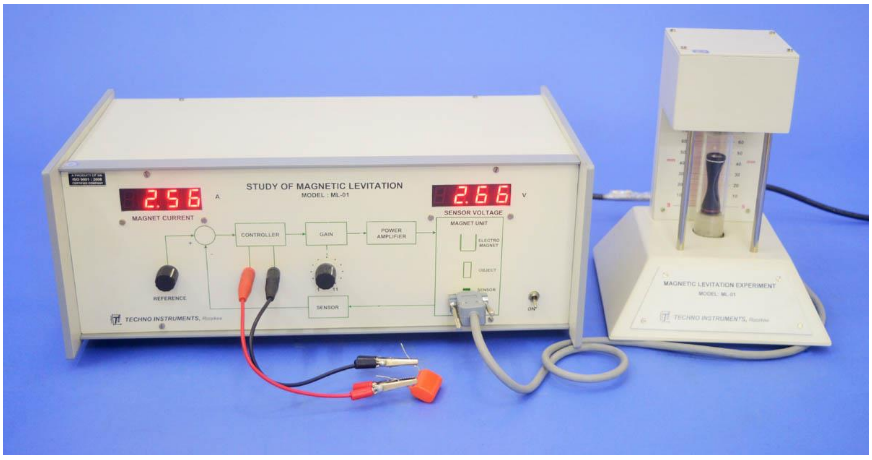
MAGNETIC LEVITATION SYSTEM

ML-01

- **Object suspended in air by magnetic force – excellent visual impact**
- **Controller design to maintain stability**
- **Up-down position setting by reference control**



Introduction

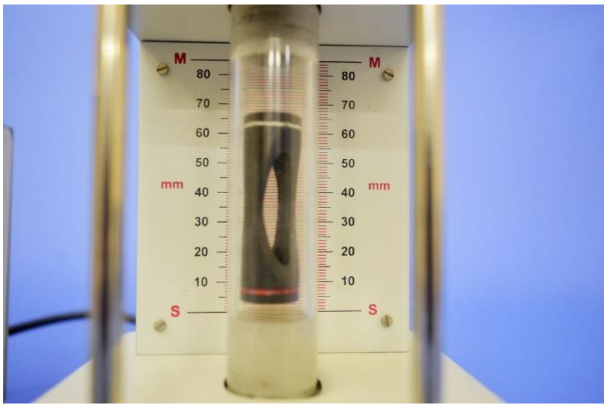
Magnetic Levitation, lifting of objects under the influence of a magnetic field, has numerous application including some advance locomotives designed on the repulsive force of a magnet. The present unit, base on the attractive force of an electromagnet, is inherently unstable. There is no way to keep an iron object suspended in air by manually adjusting the current in the electromagnet. Even a feedback control with forward path gain control alone is ineffective. These facts are brought out by studying and experimenting with the dynamics of the system. The next task consists of the design of suitable controller and implementing the same to achieve the desired objective. A sound knowledge of MATLAB and its availability should be highly desirable, though not essential, for the conduct of this experiment. The basic theory, analysis and sample calculation are described in the accompanying literature.

Experiments

- To develop the transfer function of the system through laboratory
- To design/implement PD and lead compensation with different parameter
- To simulate the system in MATLAB and study in detail various control option and their response

Features and Specifications

- Object suspended in air by magnetic force
- Controller design to maintain stability
- Position changing by reference
- Built-in power supplies, meters etc
- 220V/50Hz operation
- Detailed technical literature included



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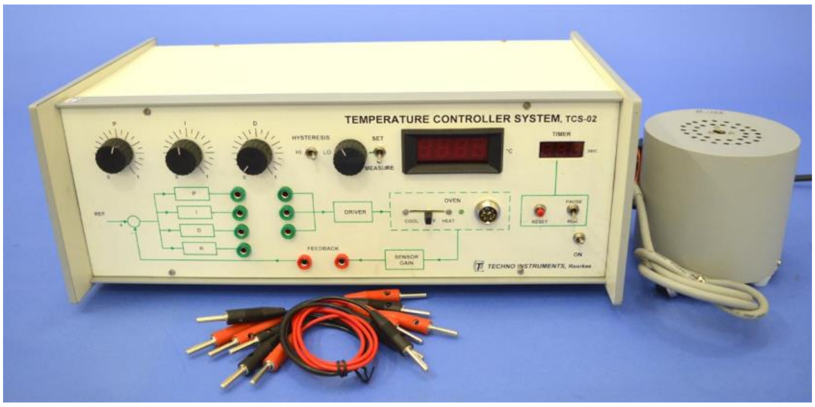
TEMPERATURE CONTROL SYSTEM TCS-302

- **Fast compact oven up to 90°C**
- **Forced cooling option**
- **Variety of control actions**
- **Digital temperature readout**
- **Built-in timer, 0-9999 sec.**
- **Solid state temperature sensor**
- **Option for MATLAB interfacing**



Introduction

Temperature control is an important application of control theory to industrial processes. This experiment has been designed to expose the students to such a practical control system, its various stages for control, and the tuning of a PID controller. The process consists of a small and fast responding oven which can be controlled in the temperature range from ambient to about 90°C. Temperature readings may be taken manually on a 3½ digit meter, mounted on the main unit, at regular intervals. A built-in digital timer having 'START', 'STOP' and 'PAUSE' switches on the panel makes the conduct of an experiment very simple. This design of the oven avoids expensive accessories like an X-Y recorder for conducting the experiment. A forced cooling arrangement has been provided to bring the oven temperature down to room temperature after every experiment. Since the oven may be cooled to the ambient relatively speedily, a number of cycles of experimentation are possible in the usual laboratory hours.

The oven is connected to the main unit through a four pin connector, two for the sensor output and the others for controller output to the heater. The main unit has provisions for configuring any type of controller such as P, PI, PD, PID or ON-OFF, and has potentiometer controls for PID coefficient settings. All supplies and metering system are built-in and no accessories are required.

Open loop response of the oven is obtained by applying a step command with feedback disconnected. Temperature readings are noted and the plot so obtained provides the characteristics of the oven, i.e., its time constant and time delay.

The simplest form of controller is a relay which switches the oven ON and OFF. Presence of hysteresis is essential for avoiding excessive relay switching, of course at the cost of accuracy. The performance is studied here for the two hysteresis settings of the built-in 'electronic relay'.

PID controllers may be set or tuned by many different methods. In this experiment the design method of Ziegler-Nichol is suggested for setting the coefficient potentiometers and the resulting response curve is studied. Other methods may also be used equally easily.

The literature accompanying the unit describes in detail the mathematical concepts, procedure for experiments and a few test results. A number of additional experiments may also be planned by the teacher using books and literature on this subject which is suggested in the references given.

All the above experiments may also be conducted on a PC through MATLAB using our optional interfacing accessory available along with the necessary literature.

Experiments

- Identification of the oven parameters
- Study of ON-OFF temperature control (with adjustable relay characteristics)
- Study of P, PI, PD and PID controls having adjustable coefficients
- Set the PID parameters and control the oven from a computer in the MATLAB environment

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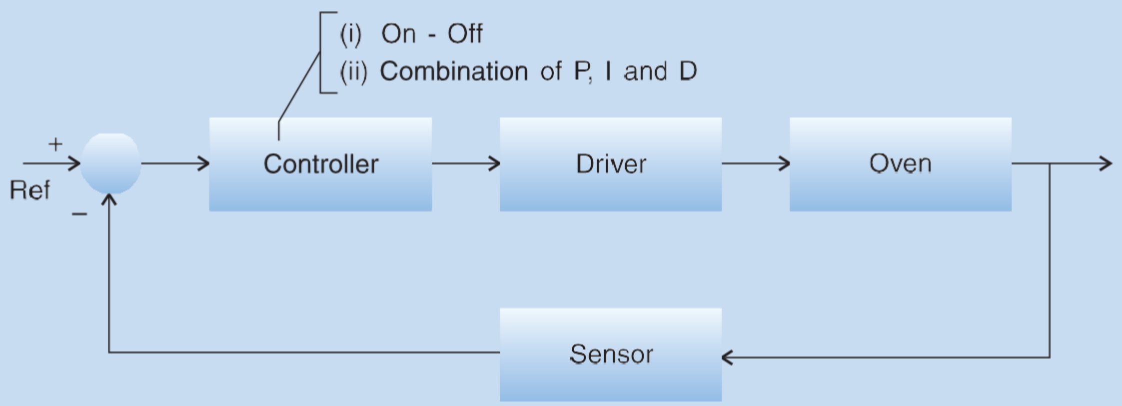
Features and Specifications

- Temperature controller with facilities for P, I, D and relay control blocks
- Operating temperature: Ambient to 90°C
- Separate controls for P, I, D channel gains
- Two settings for relay hysteresis
- Fast 25W oven fitted with IC temperature sensor
- Forced cooling option to ready oven for next experiment
- Digital display of set and measured temperature on a 3½ digit built-in DVM
- 0-9999 sec, timer on panel for a convenient temperature response experiment
- Buffered output for recorder
- IC regulation in controller circuit power supplies
- 220V±10%, 50Hz mains operation
- Supporting literature and patch cords included
- No accessories required
- Optionally the complete experiment may be performed on a personal computer in the MATLAB environment. The system is to be connected to the computer through an interface provided (TECH-CAMM). Necessary details for the operation are included in the literature.

Schematic Diagram



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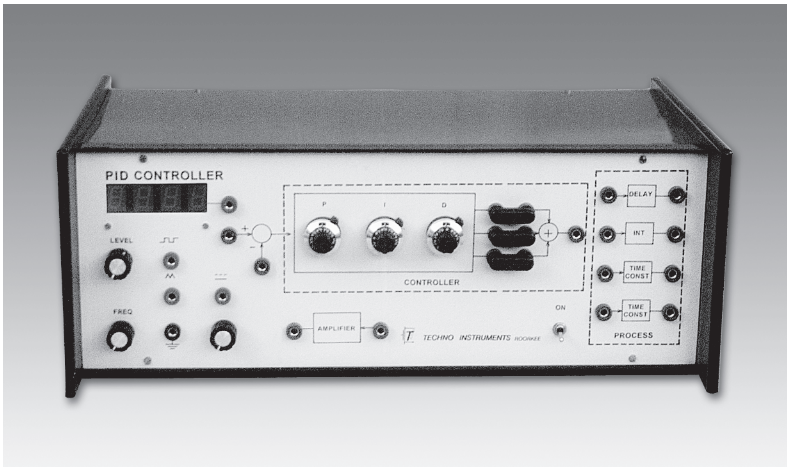
PID CONTROLLER

PID-01

- **PID - action study on CRO**
- **Simulated blocks for flexible system**
- **Time delay (transportation lag) block**
- **Synchronised square and triangular source for flicker free display**



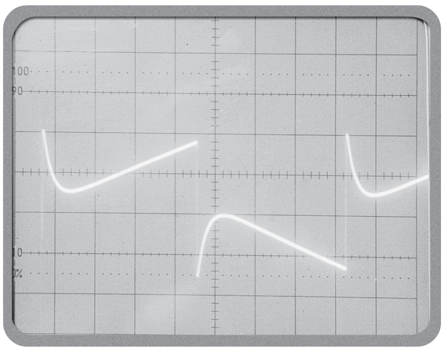
Introduction

Proportional-Integral-Derivative (PID) control has been especially popular in industrial processes like chemical, petroleum, power, food and manufacturing industries. These systems are usually slow, complex and are characterised by relatively incomplete or uncertain mathematical description. The PID controller, parameters of which may be adjusted experimentally, is therefore particularly attractive in such situations.

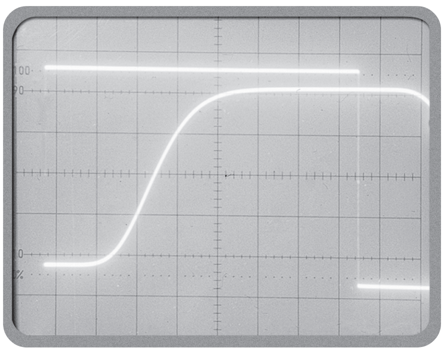
The experimental unit consists of simulated building blocks like error detector, dead time, integrator and time constants, which may be configured into a variety of systems. A PID section with adjustable proportional gain, derivative and integral time constants provide the control action. Built-in set value, square and triangular sources enable the students to study the response on a CRO. The accompanying literature includes system description, theory, experimental procedure and typical results. An important feature of the system is that the simulated blocks are designed to operate at frequencies suitable for CRO viewing. The effect of controller parameter adjustments are therefore seen immediately. No expensive recorders are required for conducting the experiments.

Experiments

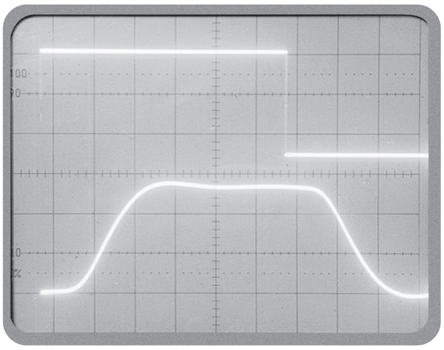
- Open loop response of various process configurations (10 in all)
- Study of closed loop response for above
- P, PI, PD and PID design and performance evaluation in each case



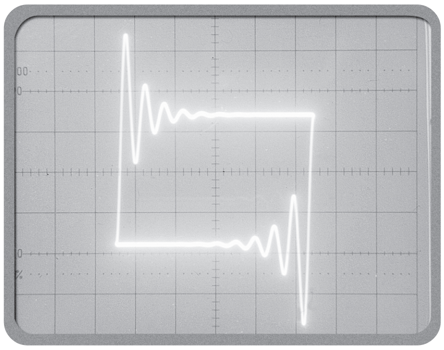
Response of PID block



Time delay display



Well adjusted PID response

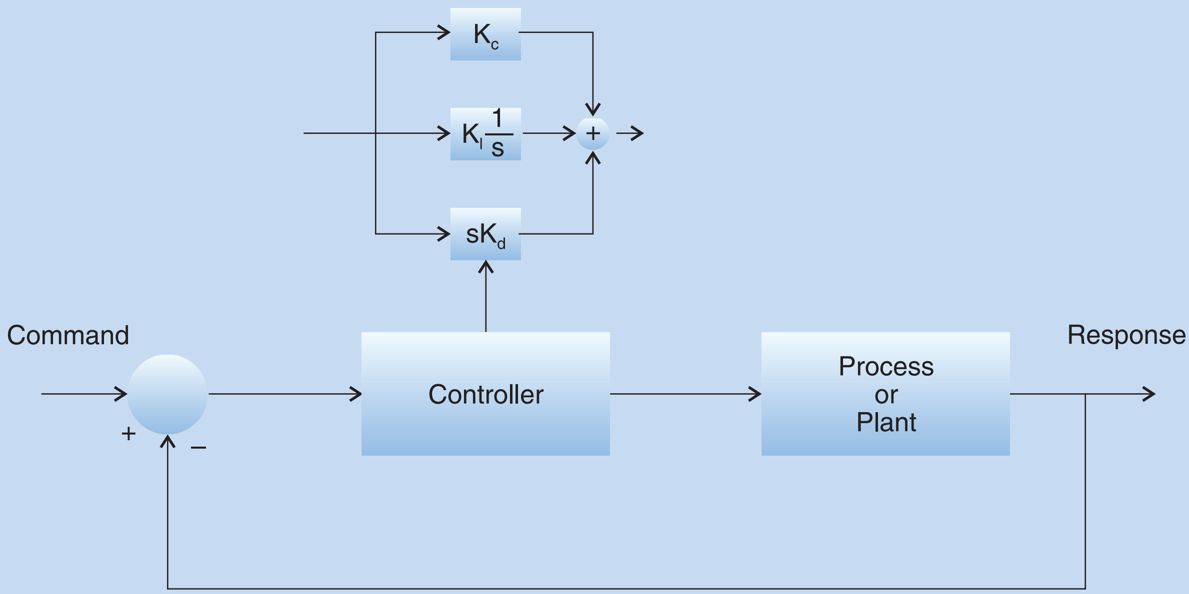


X-Y display

Features and Specifications

- Simulated blocks – dead time (transportation lag), integrator, time constants, error detector and gain
- PID Controller (configurable as P, PI, PD or PID)
  Proportional Band: 5% to 50% (Gain 2-20)
  Integral time: 10msec - 100msec
  Derivative time: 2-20msec
- Built-in signal sources
  Set value: -1V to +1V
  Square wave: 1V p-p (min.) at 40Hz (typical)
  Triangular wave: 1V p-p (min.) at 40Hz (typical)
- Built-in 3½ digit DVM for d.c. measurements
- Built-in IC regulated power supply
- 220V±10%, 50Hz mains operation
- Detailed literature and patch chords included
- Essential accessory – a CRO

Schematic Diagram



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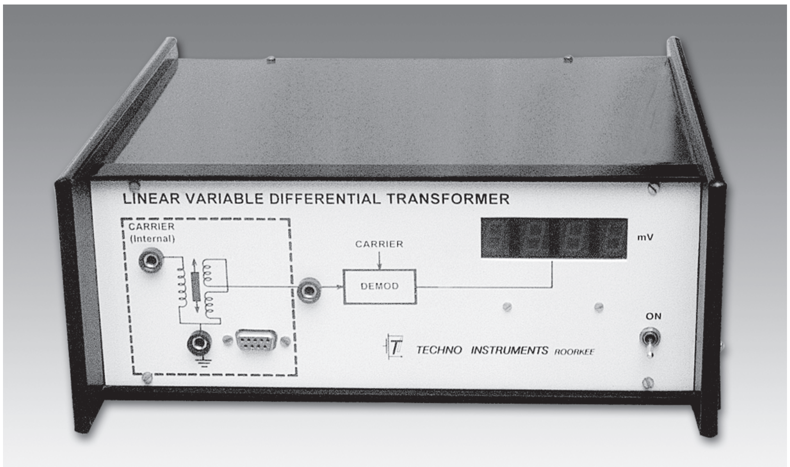
LINEAR VARIABLE DIFFERENTIAL TRANSFORMER

- **Large size LVDT for class room**
- **Transparent casing for proper viewing**
- **AC and DC output**
- **Slow motion displacement**



Introduction

A Linear Variable Differential Transformer (LVDT), is a transducer for linear displacement measurement. Using suitable accessories, the LVDT can be used for pressure measurement, weight measurement, liquid level sensing etc. The principal features of LVDT are its good linearity and high sensitivity in a large range.

The present experimental unit comprises of a LVDT in a transparent box with lead screw based slow motion displacement, a mm scale for displacement measurement, and main unit consisting of excitation signal source, balanced demodulator, a 3½ digit DVM and necessary power supplies. The signals are provided to the LVDT box through a cable from the main unit.

The unit is supplied with a detailed user manual which explains the theoretical background alongwith procedures for conducting the experiments and tabulating the results. Some typical results and references are also given.

Experiments

- Variation of modulated output with displacement
- Input - Output characteristics
- Determination of linear range and transducer gain

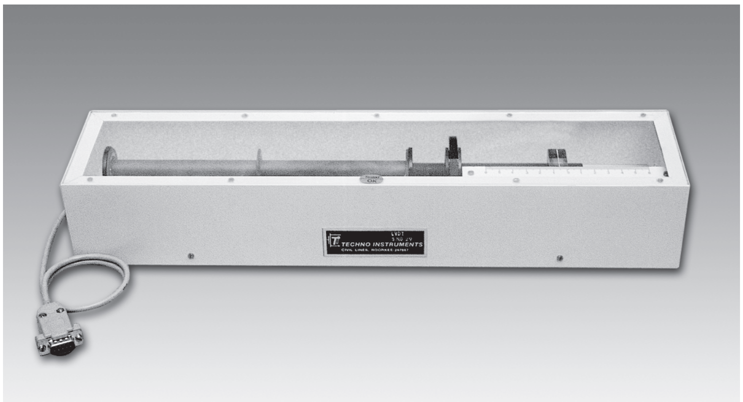
Features and Specifications

- LVDT

  Range: ±50mm or total 100mm (typical)
  Sensitivity: 25mV/cm (typical)
  Operating frequency: 5KHz±5%

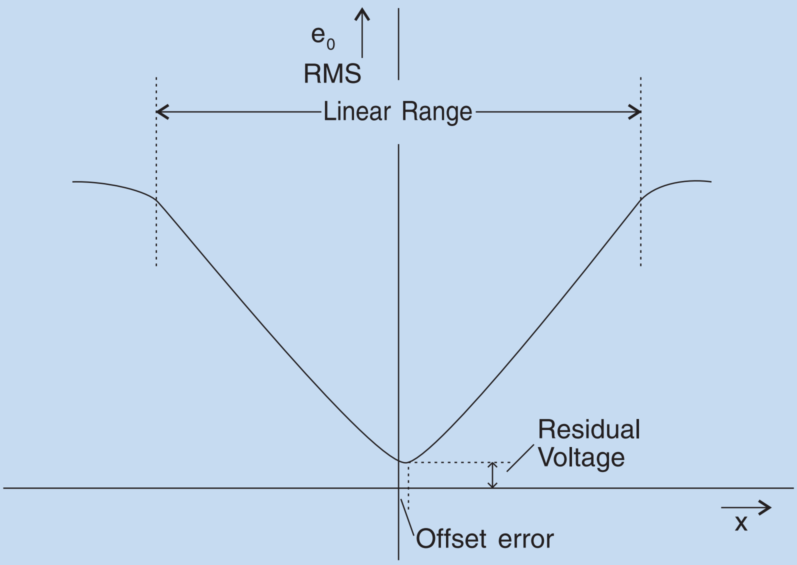
- Displacement measurement on a mm scale with fine motion control
- Carrier source (internal): 5KHz±5%; 1.5V (nominal)
- Built-in 3½ digit DVM for output reading

- IC based balanced demodulator circuit
- IC controlled internal power supplies
- 220V±10%, 50Hz mains operation
- Essential accessory – a CRO



Mechanical unit

Characteristics



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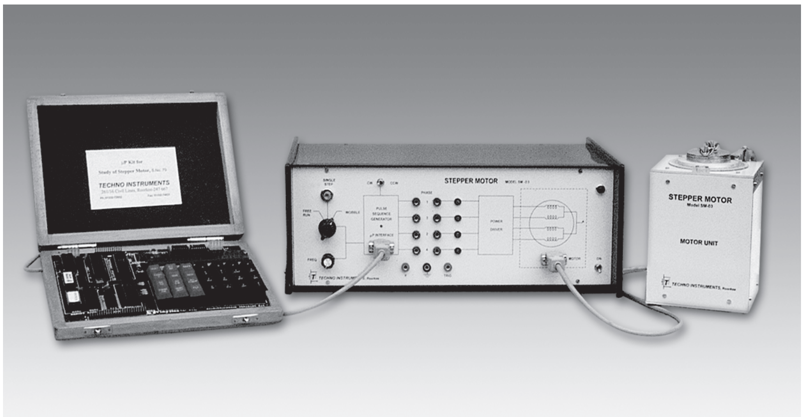
STEPPER MOTOR SM-03

- **Stepper motor operation through pulse circuit**
- **Stepper motor operation through 8085 kit**
- **Built-in programs in EPROM**
- **Dynamic response study**



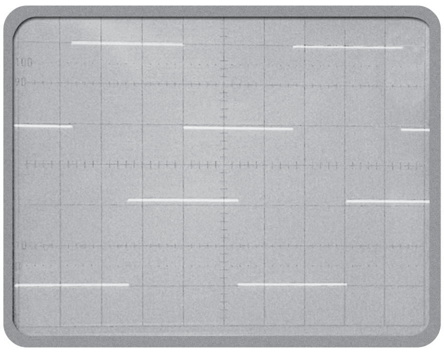
Introduction

With the rapid advancement in digital electronics, the stepper motor by virtue of its being a direct digital actuator, has become an important element of a control system. Well known applications include watches, floppy and hard disk drives, printers etc. This experimental set-up aims at providing an exposure to the basic operation of a stepper motor, its drive and logic, and limitations as far as the internal dynamics is concerned. Experiments have been designed to demonstrate the effect of external load – inertial and frictional, on the motor performance. Provisions are available for free running operation as well as single stepping mode with LED indication for the active phase. The unit may also be operated by a microprocessor kit for which a built-in interfacing and automatic changeover has been provided.
It may be seen that this is a complete experiment set and not a microprocessor kit with an ADD-ON card and a motor.

An exhaustive literature is supplied with the unit explaining in details the theory of stepper motors, procedure for conducting the experiments and interpretation of the results. The details of application software are also included.

Experiments

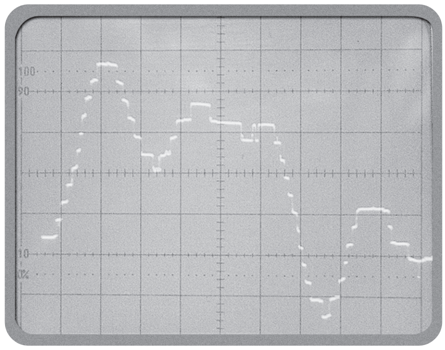
- Study of manual stepping through push button switch - it would enable the student to appreciate one to one correspondence between the number of steps and shaft movement. A 360° calibrated dial is used for the measurement of step angle
- Study of speed and direction control logic by recording the pulse sequence for both clockwise and counter clockwise motions
- Study of resonance effect at various speeds - it provides an idea of the dynamic behaviour of the motors
- Display and measurement of the dynamic characteristics of the motor on the CRO while the motor is given a to-and-fro motion in the wobble mode. This enables one to calculate 'single stepping' and 'slew' regions
- Programming the microprocessor kit to implement various features like direction, speed, prescribed angle of rotation, prescribed number of steps or an arbitrary motion
- Application software is included for demonstration and also for use as a set of subroutines
- Study of the effect of inertial and frictional loading on the dynamic performance



Phase voltages of two phases

Features and Specifications

- Single stepping and free running modes of operation with speed variation and direction reversal - internal TTL circuit.
- 360° motion Servo-Potentiometer position-pickup for motor dynamics
- Operation through microprocessor kit – sample control programs provided
- Stepper motor specification
  Torque: 2.8 Kg-cm
  Step angle: 1.8°
  Power: 12V, 1A/phase
- 220V±10%, 50Hz mains operation
- Complete in all respects, except a measuring CRO



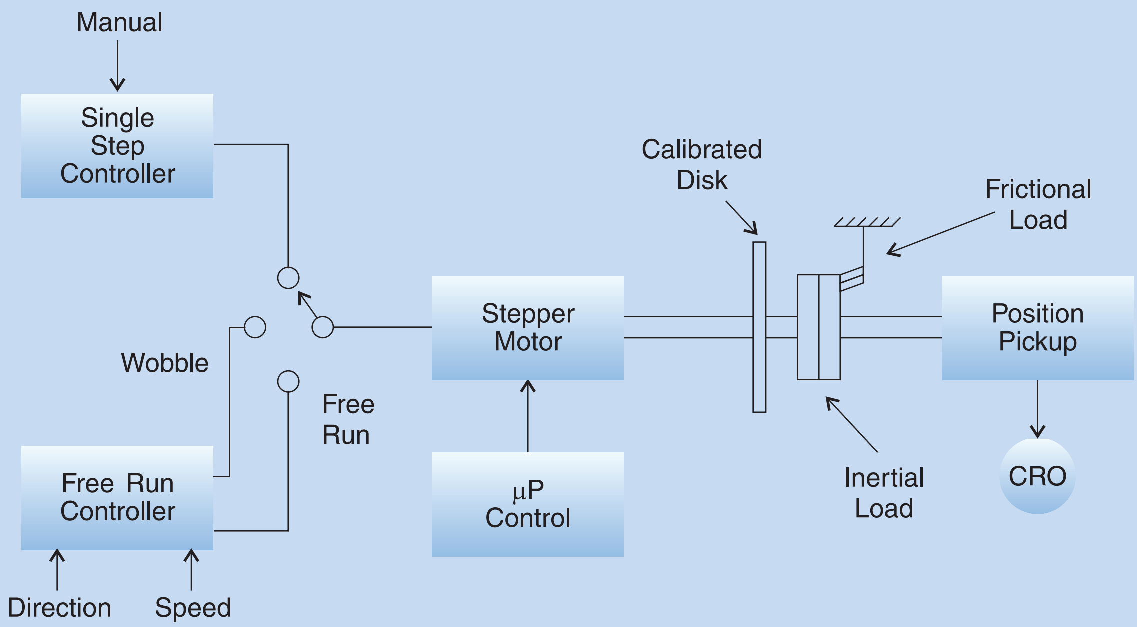
Dynamic Response

Technical Specifications of the μP Kit Supplied

- High performance 8085A CPU operating at 3MHz
- 4K powerful monitor FIRMWARE in 2732. Includes all standard commands, codes, functions and utility sub-routines
- 4K user RAM 6116
- Versatile Keyboard/Display controller using 8279
- Serial I/O lines, 22 parallel lines from 8155 and 24 from 8255
- Built-in audio cassette interface
- 6 digit seven segment LED display
- Power Supply: Built-in in the Stepper Motor Unit

Motor unit

Schematic Diagram



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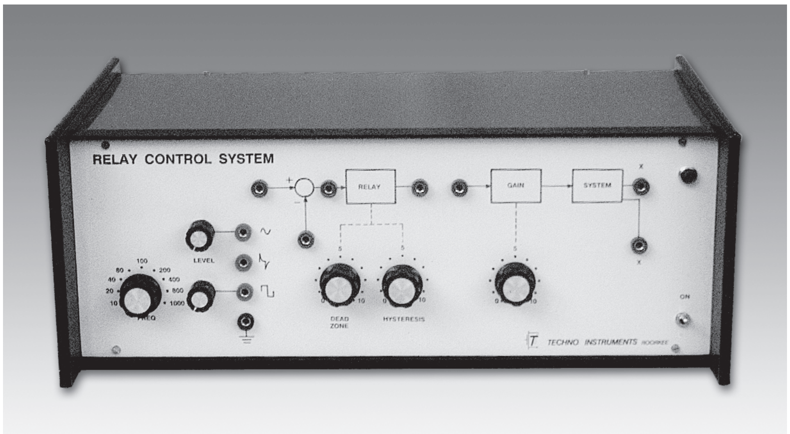
RELAY CONTROL SYSTEM

RCS-01

- **System with electronic relay**
- **Adjustable hysterisis and dead zone**
- **Display phase plane diagram on CRO**
- **Stability study by describing function method**

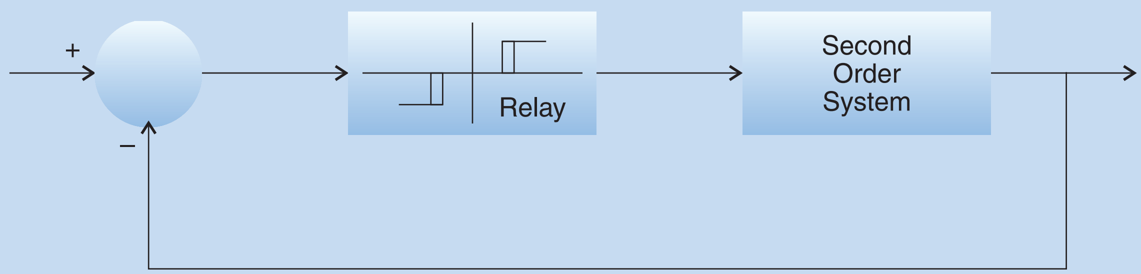


Introduction

Most physical systems are nonlinear to some extent, however, for purpose of analysis and design these are taken as nearly linear. In a few systems nonlinear elements are deliberately introduced to get some specific advantage. One such system is a relay control system, often referred to as bang-bang or ON-OFF system. The controller in such a system is replaced by a power relay resulting in a substantial cost reduction. In the present unit a simulated second order system is controlled by an electronic relay. Apart from a study of the relay characteristics the experiment introduces the concept of Describing Function. Finally the phase plane method of analysis is covered in detail where the switching trajectories can be displayed on an X-Y oscilloscope. Figures below give the block diagram of the feedback system and the characteristics of the simulated relay.

The accompanying literature covers a brief treatment of the nonlinear system analysis through Describing Function and Phase Plane methods. Steps for conducting various experiments are described along with sample test results.

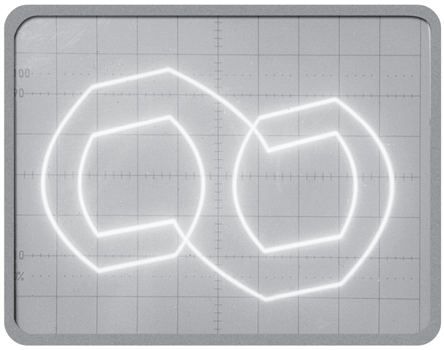
Schematic Diagram



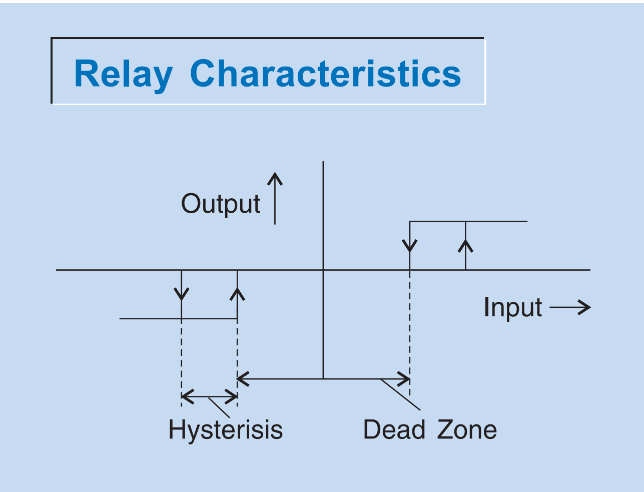
Experiments

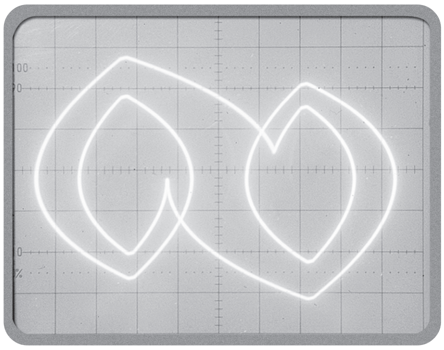
- Study of the relay characteristics and display of the same on CRO for different values of hysteresis and dead zones. Hysteresis and dead zone of the built-in 3-position electronic relay are adjustable in the range 0-600mV and 0-500mV respectively. The transfer characteristics and output of the relay under various settings provide insight into the relay performance

- Study of the effect of hysteresis on system stability. Sustained oscillations may occur in the system under various conditions, especially where hysteresis is present. The amplitude and frequency of such oscillations are predicted from a graphical analysis and then verified experimentally on the unit
- Phase plane analysis of relay control system for various values of Hysterisis and Dead Zones. The nature of the singular point in the phase plane diagram has importance in the stability studies of nonlinear systems. Here the phase trajectory is viewed on the CRO and the effect of changing hysteresis and dead zone observed



Relay with deadzone





Linear system

Features and Specifications

- Simulated electronic relay using high speed IC's
- Simulated 2nd order linear plant. Facility for displaying x and ẋ signals
- Dead zone variable from 0-600mV (approx.)
- Hysteresis variable from 0-500mV (approx.)
- Built-in signal sources – sine and square
  Amplitude : 0-1V (min.) variable
  Frequency: 10, 20, 40, 80, 100, 200, 400, 800 and 1000Hz
- IC regulated internal power supplies
- 220V±10%, 50Hz mains operation
- Literature and patch cords included
- Essential accessory - a dual beam CRO

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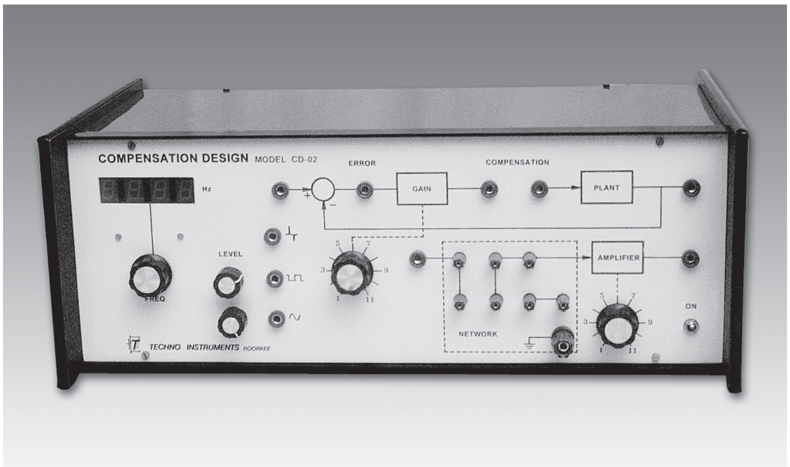
COMPENSATION DESIGN CD-02

- **Design and test cascade compensator**
- **Simulated system for accurate results**
- **Built-in compensator gain – only passive external components needed**
- **Built-in signal sources**



Introduction

Practical feedback control systems are often required to satisfy design specifications in the transient as well as steady state regions. This is usually not possible by selecting good quality components alone, due to basic physical limitations and characteristics of these components. Cascade compensation is most commonly used for this purpose and the design of compensation networks figures prominently in any course on automatic control systems. Due to the absence of any laboratory experience, however, the concepts of compensation remain rather vague. This unit has been designed to enable the students to go through the complete design procedure and finally verify the performance improvements provided by compensation.

A simulated second order system with variable gain is taken as the 'unsatisfactory system'. Simulated system has the advantage of predictable performance which is necessary if the verification of the results is to be meaningful. Built-in variable frquency square wave and sine wave generators are provided for time domain and frequency domain testing of the system. The frequency may be varied in the range 25Hz – 800Hz and its value read on a built-in frequency meter on the panel. Although most practical control systems have bandwidth upto a few Hz only, a higher bandwidth has been chosen for the simulated system to facilitate viewing on a CRO. A pre-wired amplifier makes the implementation of the compensation network extremely simple. Only a few passive components need plugging into the circuit. Lead and lag networks may be designed and tested on the set-up using both frequency domain and s-plane procedures.

The experimental set-up is accompanied by the supporting literature which becomes of vital importance as a major part of the experiment involves theoretical design of compensation networks. Although a complete coverage of design philosophy is not feasible in this document, all efforts have been made to describe the salient features and design steps of the four problems listed above. Also included is a typical design, explicitly covered with compensation network parameter calculation and final results.

Experiments

- Lag compensation in the frequency domain
- Lead compensation in the frequency domain
- Lag compensation in the s-plane
- Lead compensation in the s-plane

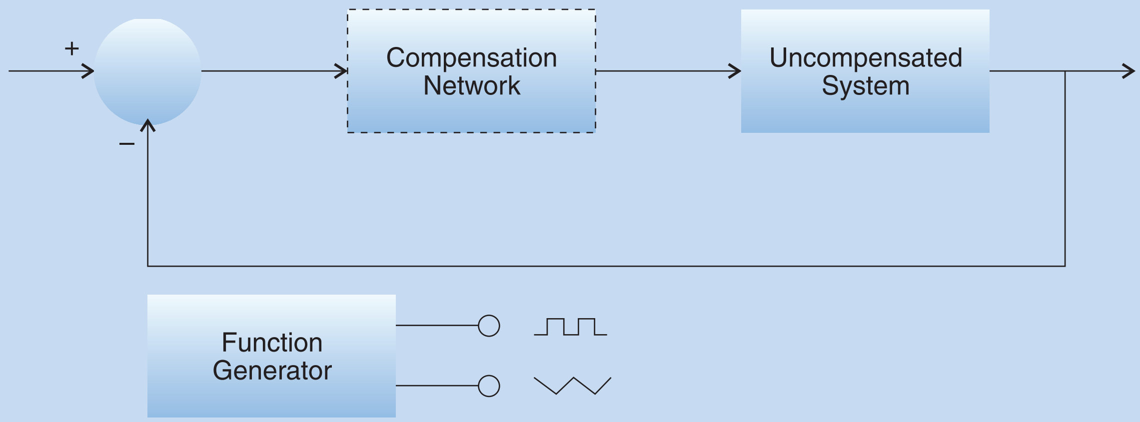
To start with, a suitable 'uncompensated system' is chosen, either by an arbitrary setting of the gain control potentiometer or by setting it to result in a given value of overshoot as seen by step response test. Next a set of specifications - both transient and steady state - are prescribed as an objective by the teacher. The design may then be carried out by one of the above techniques and the results verified by a step response or frequency response testing

All the above design problems may be undertaken for a very wide range of design specifications. Notice that the implementation of the compensation network has been made very convenient by a prewired amplifier with calibrated gain.

Features and Specifications

- Simulated 'uncompensated' system having adjustable damping. Peak percent overshoot M_P, variable from 20% to 50%, and steady state error variables from 50% to 0.5%
- Compensation network implementation through built-in variable gain amplifier. Gain is adjustable from 1 to 11
- Built-in square and sine wave generators for transient and frequency response studies. Frequency adjustable from 25Hz – 800Hz (approx.)
- 220V±10%, 50Hz mains operation
- Complete in all respects, except a measuring CRO

Schematic Diagram



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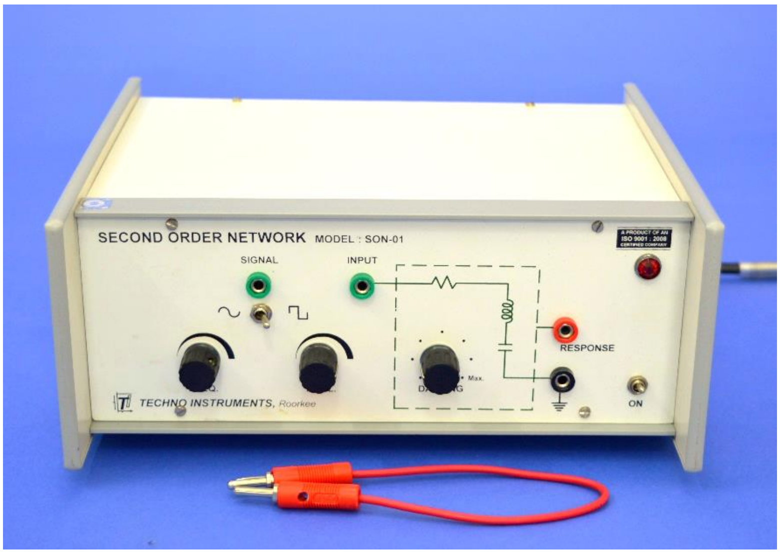
SECOND ORDER NETWORK

SON-01

- **Active second order network**
- **Damping control–over, critical, and under-damping**
- **Built-in square wave signal**
- **Built-in sine wave signal**
- **Needs an external CRO for response study**
- **Operates with 220V/50 Hz**
- **Detailed technical literature and experiment results supplied**



Introduction

Second order networks are important because of the fact that these are the simplest networks that produce the complete range of transient response – from over damping to near oscillations. Although theoretical discussions are normally confined to passive RLC networks, such networks are limited in their performance due to the rather large resistance of any reasonable value inductance that might be constructed to operate at frequencies of few kHz. In the present unit active RC-network has been designed which span the complete behaviour of an equivalent passive RLC network. The user thus has the experience of studying a near ideal passive second order network complete with all theoretical computations and their experimental verifications.

Theory

A second order RLC series circuit, Fig. 1, has the dynamic equation as,

$$e(t) = Ri + L\frac{di}{dt} + \frac{1}{C}\int idt$$

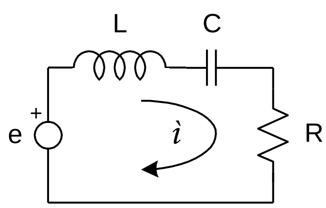


Fig.1

Taking Laplace Transform and rearranging the terms, for a unit step input,

the current is given by,

$$I(s) = \frac{\frac{1}{L}}{s^2 + \frac{R}{L}s + \frac{1}{LC}}$$

The above may be put in the standard, normalized form as,

$$I(s) = \frac{C\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

where,

$\zeta = \frac{R}{2}\sqrt{\frac{C}{L}}$ is the damping ratio, and $\omega_n = \frac{1}{\sqrt{LC}}$ is the natural frequency.

Various operating conditions, denominator roots and the resulting response may be summarized as,

$\zeta > 1$, two real distinct roots $\Rightarrow$ overdamped

$\zeta = 1$, two repeated roots $\Rightarrow$ critically damped

$\zeta < 1$, complex conjugate roots $\Rightarrow$ underdamped

$\zeta = 0$, two roots on the jω-axis $\Rightarrow$ oscillatory

The figure shown next depicts a typical current plot, i(t), for four different values of ζ,. The experiment enables the student to vary the value of damping ratio through a marked dial and observe the nature of response. The experiment suggests methods to compute approximate values of equivalent components using the data obtained from the CRO trace.

A sinusoidal excitation of the network may also be used to obtain its frequency response and observe the phenomenon of resonance for different values of damping ratio

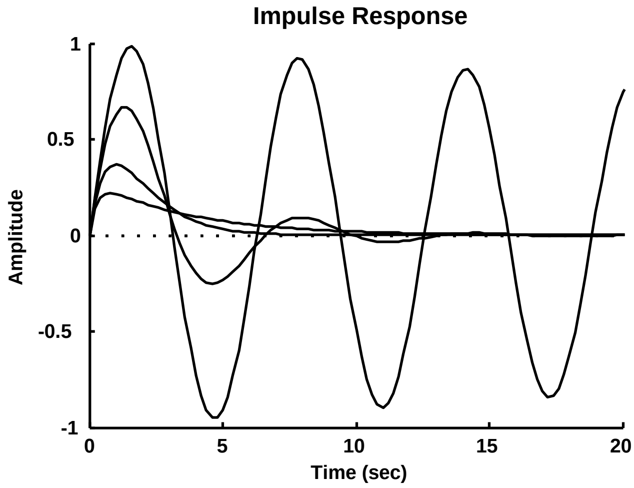


Fig.: **Step Response of Series RLC Network**

Suggested Experiments

- Observe and trace from the CRO screen the step response for different values of □.
- Compute approximate values of equivalent network parameters.
- Plot the frequency response for various values of □ and observe resonance

LINEAR SYSTEM SIMULATOR LSS-01

- **Time domain study of a Linear System**
- **Frequency domain study of a Linear System using a DDS Function Generator, an extra accessory**
- **Op-amp simulated system for greater accuracy**
- **Flexible system configuration**
- **Full details of experiments included**
- **Additional experiments possible**

Introduction

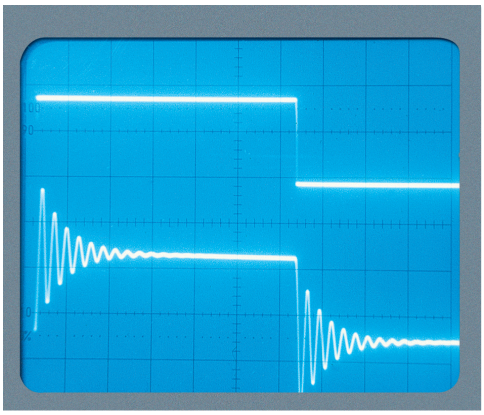
The most important performance aspect of a practical system is its response to known inputs. The analysis of such systems therefore includes time and frequency domain studies, the former has direct relevance to most practical situations while the latter offers a relatively smoother experimentation with no sharp transients. Both these methods form part of any curriculum of control systems.

The setup offered is a variable configuration simulated system designed for the study of both open loop and closed loop systems. Selection at block diagram level eliminates the need to bother about the details of electronic circuitry and its assembly. Thus time and efforts could be directed towards understanding and experimenting with the basic aspects of linear control systems.

Schematic diagram of the simulator shown includes transfer functions of the form 1/s and 1/(sT+1), a calibrated variable gain K and an error detector. These could be combined to form a variety of system configurations. The unity gain uncommitted amplifier can be used to ensure negative feedback for any combination. The time constants have been selected such that the system response may be observed conveniently on a CRO. This avoids the need to use an expensive and delicate X-Y recorder for the experiment. Built-in square wave and triangular wave generators provide test inputs to study both transient and steady state responses. Provision is also there to observe the effect of disturbances.

Frequency domain study can be performed using an external sine wave source. A DDS signal generator, Type 6600, offers a convenient and accurate phase measurement and is strongly recommended for this purpose.

An exhaustive literature is supplied with the unit to enable the students to understand and appreciate the intricacies and importance of time and frequency response studies of linear systems. Correlation between the results of both the techniques is highlighted. The description includes mathematical analysis, procedure for experiments, typical results and suggestions for additional experimentation.



Low damping ratio

Experiments

- Open loop step response of First Order type-0 system for various values of gain
- Closed loop step response of First Order type-0 system for various values of gain
- Open loop step response of Second Order type-0 and type-1 systems
- Closed loop step response of Second Order type-0 and type-1 systems
- Steady-State errors for closed loop configuration through triangular wave input
- Response of third order system
- Frequency response (Bode diagrams) of open and closed loop systems.

In each of the above, the experimental results obtained by measurements of the response curves can be compared with theoretical calculations

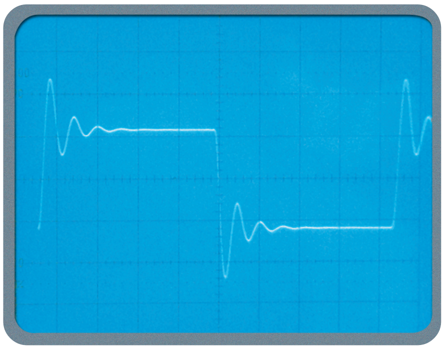
The number of experiments possible on the unit is not limited to those suggested above. Subject to the availability of time many more variations of the above are feasible

Features and Specifications

- Simulated first, second and third order system of type-0 and type-1 (4 combinations)
- Calibrated variable gain amplifier (Resolution 1 : 1000)
- Built-in signal sources: Square wave and Triangular

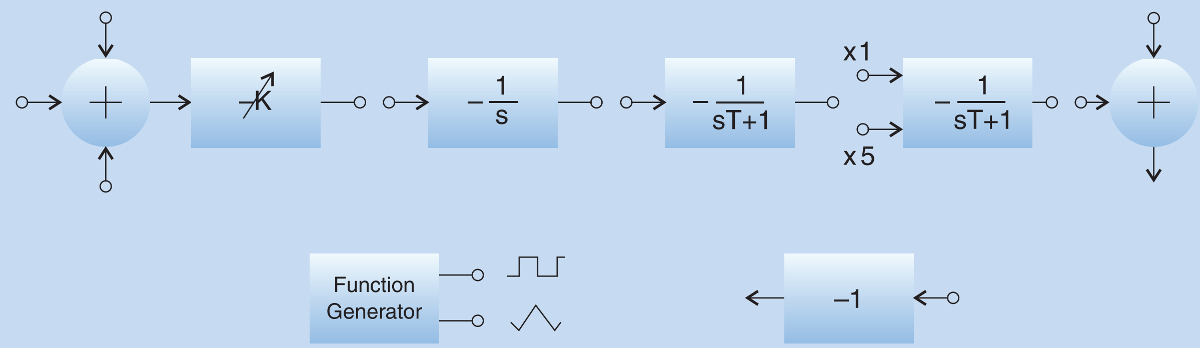
  Frequency : 45-90Hz

  Amplitude : 0-2.5V approximately
- Trigger output for perfectly steady display on CRO
- Uncommitted amplifier for phase adjustment
- Provision for disturbance inputs
- 220V±10%, 50Hz mains operation
- Complete in all respect, except a measuring CRO



Medium damping ratio

Schematic Diagram



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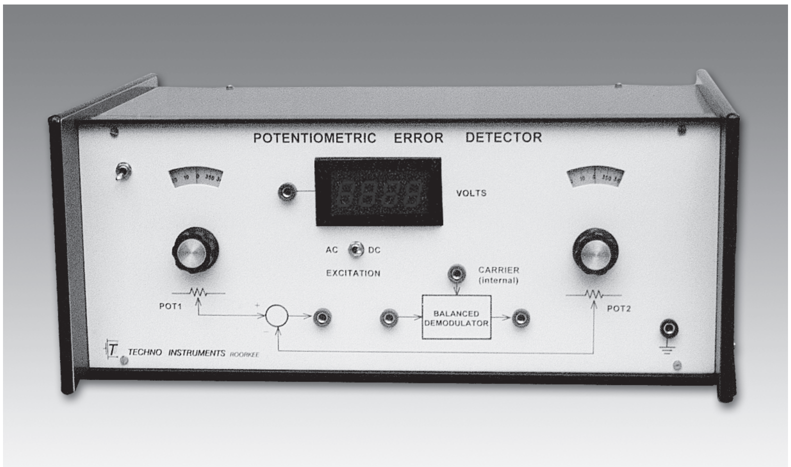
POTENTIOMETRIC ERROR DETECTOR PED-01



- **High quality servo potentiometers**
- **360° Mechanical, 355° Electrical span**
- **DC and AC operation**
- **3½ Digital Panel Meter for all measurements**

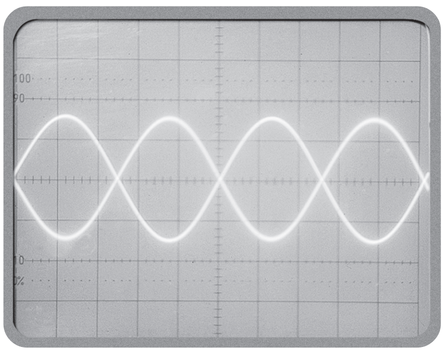
Introduction

All feedback control systems operate from the error signal which is generated by a comparison of the reference and the output. Error detectors perform the crucial task of comparing the reference and output signals. In a purely electrical system where the reference and output are voltages, the error detector is a simple comparator. In some other systems with non-electrical outputs, the output signal is converted into electrical form through a measurement or transducer block, and then error detection is performed on the electrical signals. A position control system, with both input and output variables as mechanical positions (linear or angular), may however consist of two potentiometers - reference and output, which function as an error detector. Other devices which could be used in similar applications include synchro sets (for a.c. systems), sine-cosine potentiometers, hall effect-potentiometers etc, which unfortunately are not readily available.

The present set-up is designed to study the important characteristics of a 2-potentiometer angular position error detector. These include (i) linearity, (ii) sensitivity and (iii) maximum angle of rotation. Good quality wire wound servo potentiometers with full 360° rotation have been used for this purpose. Accurately marked dials with least count of 1° are fixed on the shafts for position indication. The error voltage is read on a built-in 3½ digit DVM. An I.C. regulated internal reference voltage is available for d.c. studies. When used with an a.c. reference, the unit also demonstrates the phase reversal of the error signal which is important in applications involving a 2-phase servomotor as actuator.

Experiments

- Linearity study of the error detector
- Determination of error detector gain
- Use of a.c. supply for the error detector-introduction to the phase reversal of error signal

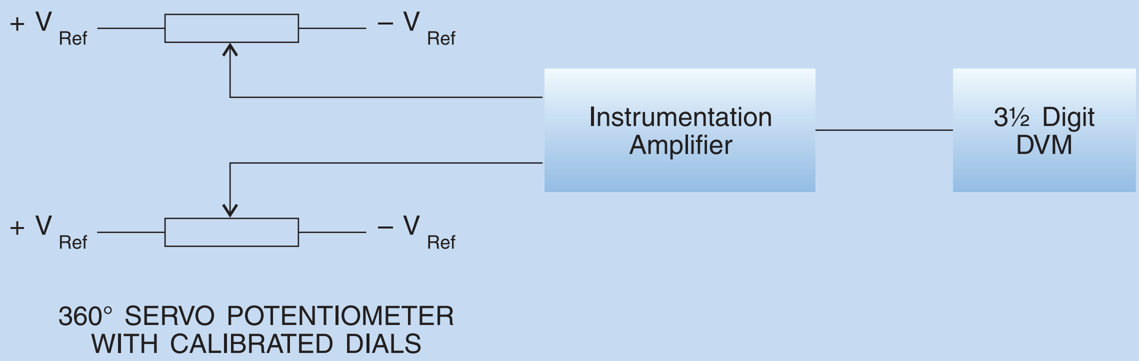


Phase reversal of error

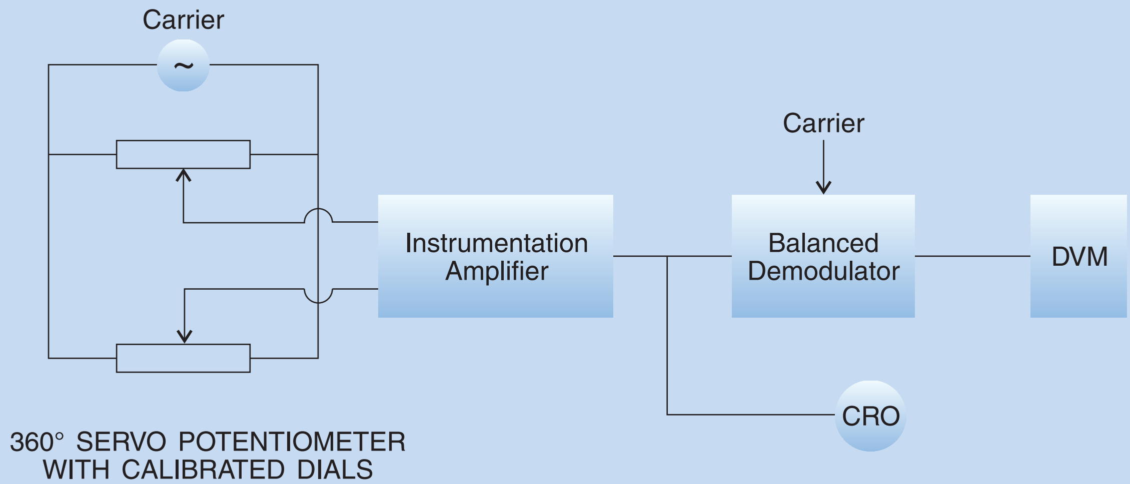
Features and Specifications

- High quality servo-potentiometers of 360° shaft rotation
- Built-in signal and power sources
- 3½ digit DVM for measurements
- 220V±10%, 50Hz mains operation
- Requires an external CRO for a.c. studies

Schematic Diagram



D.C. Operation



A.C. Operation

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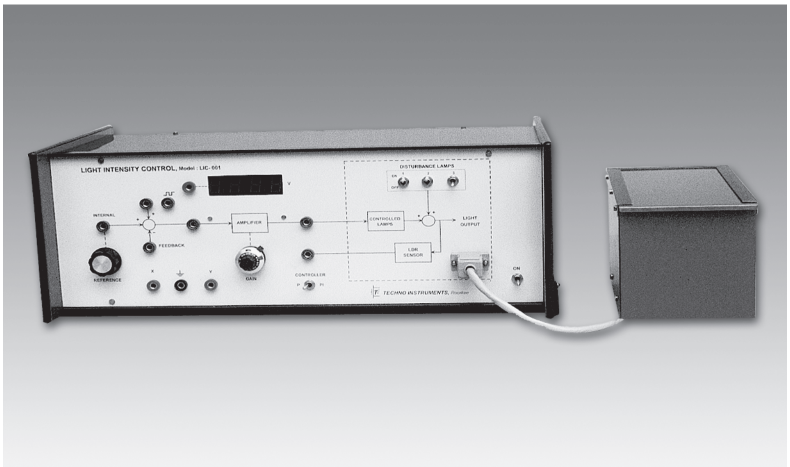
LIGHT INTENSITY CONTROL SYSTEM LIC-01

- **Feedback control of light intensity**
- **Study of inherent non-linearties-sensor, lamps**
- **PI control**
- **Dynamic response display**

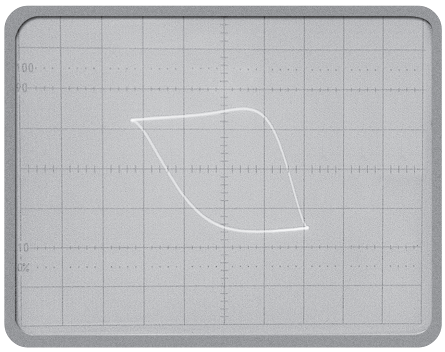


Introduction

Feedback is applied in a variety of systems to control different physical variables. In contrast with systems without feedback (open loop systems), the feedback systems (closed loop systems) have lower parameters sensitivity, higher disturbance rejection and greater accuracy. The light intensity control system is designed to bring out these features in the form of a laboratory experiment. The light panel comprises of a number of filament lamps which get power from amplifier. Average intensity of the panel is sensed by a light sensor and a suitable voltage level is produced. Error detector, reference input and error amplifier are of standard configurations found in any linear control system. In addition to the above, the light panel also contains a few uncontrolled lamps which may be used as disturbance source. Further a square wave signal is available for dynamic response studies. Measurement points are provided for monitoring the performance of the system. A detailed user's manual comprising of the system description, experiments to be conducted and typical results is supplied with the set-up.

Experiments

- Characterization of light panel and light sensor blocks
- Study of a practical single loop feedback control system which includes:
  - Disturbance study
  - Error monitoring
- Performance improvement through P-I control
- Evaluation of dynamic behaviour
- Seven lamps 6V/300mA
- 5Hz square wave and triangular wave for dynamic response study
- Switch selectable PI-Controller

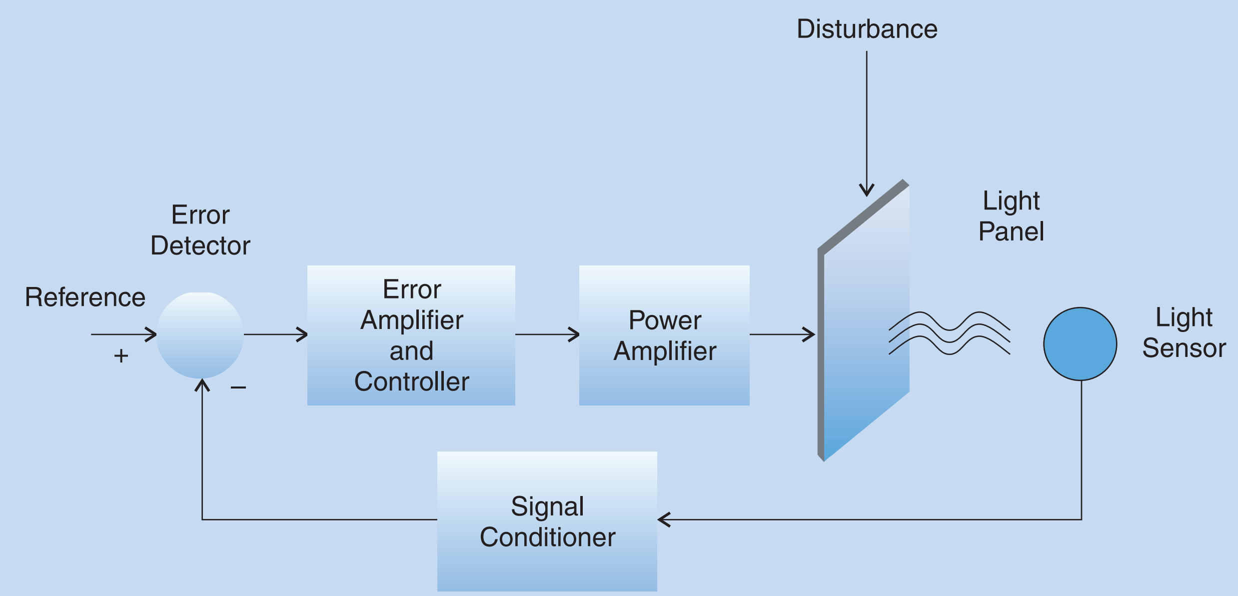


Dynamic response of lamps

Experiments

- Built-in 3½ digit DVM
- Built-in IC regulated power supplies
- 220V±10%, 50Hz Mains operation
- Detailed literature and patch cords included

Schematic Diagram



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MICROPROCESSOR DEVICE CONTROLLER
MDC-01

- **Sequence control of 8 LEDs through 8255 port**
- **Control of 2 relays**
- **Operating a 7-segment display**
- **Switch state input through 8255 port**
- **SID/SOD Operation**

Introduction

This unit has been designed to train the students to handle basic input-output operations of the 8085 micro-processor through 8255 ports. The power supply, drivers and other hardware are pre-wired resulting in a greater reliability of operation. The students are expected to enter a few suggested programs and also to develop their own programs for a variety of input-output operations, which include,

a) Light the 8 LEDs in a cycle, in binary sequence, as a bar graph display etc.

b) Operate the 2 relays with software controlled timing

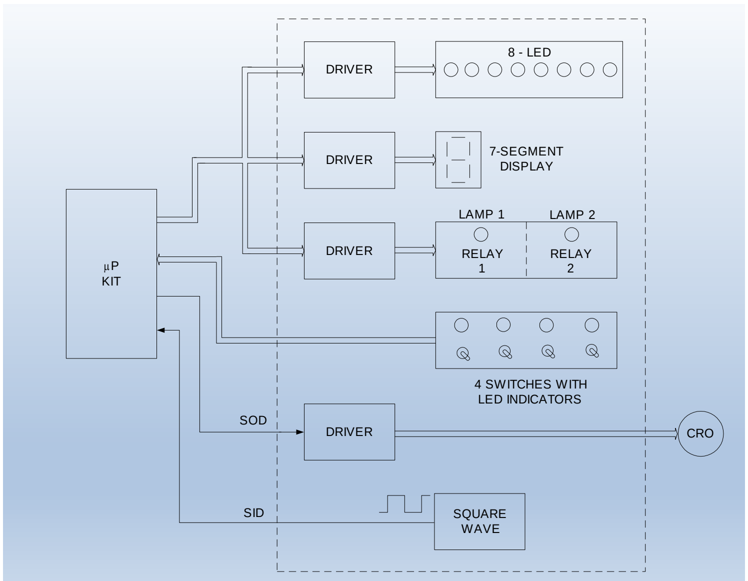
c) Operate the 7-segment display through segment control

d) Sense the state of the 4-switches as input and send out suitable signals to various output devices.

e) Study of SID/SOD

The system comprises of a main unit and a µp kit, connected through a flat cable. The main unit houses all the I/O devices, viz. LED's, relays, 7-segment display, switches and their drivers/ interfacing circuits. In addition the status of the relays and switches are displayed with the help of lamps mounted on the panel.

Schematic Diagram



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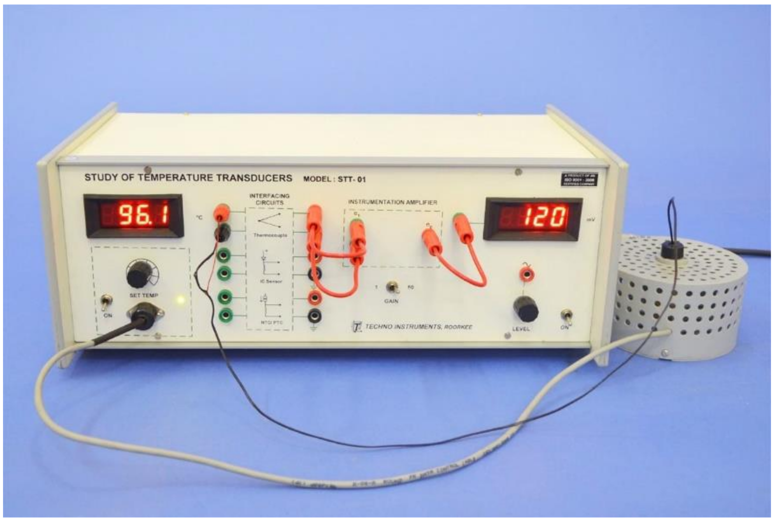
STUDY OF TEMPERATURE TRANSDUCERS

STT-01

- **Temperature controlled oven with digital display**
- **Instrumentation amplifier with gain switching**
- **Digital voltmeter**
- **Interfacing circuits for common transducers**



Introduction

Measurement of temperature is an important task in a large number of physical processes. A transducer in a device which converts the temperature information into an electrical signal, usually voltage, for an automated processing. A very wide variety of temperature transducers are commonly available which differ from each other with regards to there:

a) Range of operation
b) Sensitivity and linearity
c) Accuracy, Stability and Repeatability
d) Speed of response

The present experiments has been designed to study the input-output characteristics of some common transducers like, thermistors (PTC and NTC), thermocouple, semiconductor sensors and may be extended to also study the temperature coefficients of resistances.

The main requirements for an experiment of this nature are,

a) A precisely controlled from oven with a temperature display which is fast
b) An adjustable gain instrumentation amplifier which may be used to amplify the different levels of signals from transducers
c) Interfacing circuits suitable for the transducers used.

Experiments

- Temperature-output voltage characteristics of the following transducer groups in the temperature range of room temperature to 150º C and determination of their parameters
- Thermocouple : Chromel-Alumel/ Copper-Constantan
- Thermistor : Negative Temperature Coefficient/ Positive Temperature Coefficient
- Semiconductor Sensor : AD590/ LM35 (upto 90ºC only)
- One sensor from each group is supplied with the unit

Features and Specifications

- Temperature controlled oven upto 150ºC with digital temperature display
- Digital voltmeter on the panel for sensor output measurement
- Built-in interfacing circuit and switched gain instrumentation amplifier
- IC regulated power supplies and detailed manualSupporting literature with experiment details

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DIGITAL TO ANALOG CONVERTER

DTA-01

- **Basic 4-bit weighted resistance**
- **4-bit R-2R network module**
- **10-bit IC Type AD7533 with mechanical switches**
- **Microprocessor interfaced 10-bit Converter**

Introduction

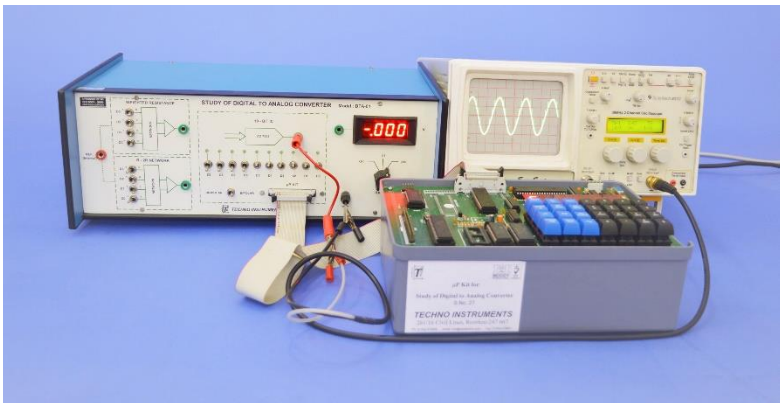
Digital systems have become extremely common in almost all facets of modern life, be it consumer electronics, entertainment electronics, photography, medical electronics, industries, communication or any number of simple and complex systems. One of the major reasons for this development is the ease with which digital signals can be processed, stored, transmitted and converted to the form suitable for our use. This situation has been helped by the advancement in technology which has resulted in a vast reduction in cost of the devices and an enormous increase in their capabilities. An application which was not technically or economically feasible say five to ten years back is now a household item. An example is a digital camera. There are now more and more complex and sophisticated systems which are becoming commonplace every day. It is therefore imperative for all students of science and engineering to familiarize themselves with at least the basic processes involved in a digital system. The present unit is designed with the aim to study the techniques of conversion of digital signals into analog form which is an integral part of any digital system.

The digital-to-analog converter (D/A converter), as the name suggests, is a block placed towards the end of a digital system which typically converts the digital signals obtained after all processing into an analog form suitable for our comprehension. As a simple example, the digital music recorded on a CD must be decoded by some processor and converted to analog form before it is amplified and fed to a speaker to generate the sound signals that we can hear.

There are two basic techniques of D/A conversion, viz., weighted resistance method and R-2R network method. While the first is of theoretical interest only, it is the second method which finds widespread application. In the present experimental unit both these methods are explored using discrete component based 4-bit circuits and also an IC based 10-bit system. These enable the user to study the basic performance of the converter circuits. In addition, an 8085 microprocessor and interfacing circuit is provided for the student to perform some advanced experiments to gain a better insight into realistic application of these circuits. These include generation of arbitrary waveforms of different frequencies, producing a voltage-time profile and simple signal processing experiments. A knowledge of assembly language programming is a pre-requisite for this section.

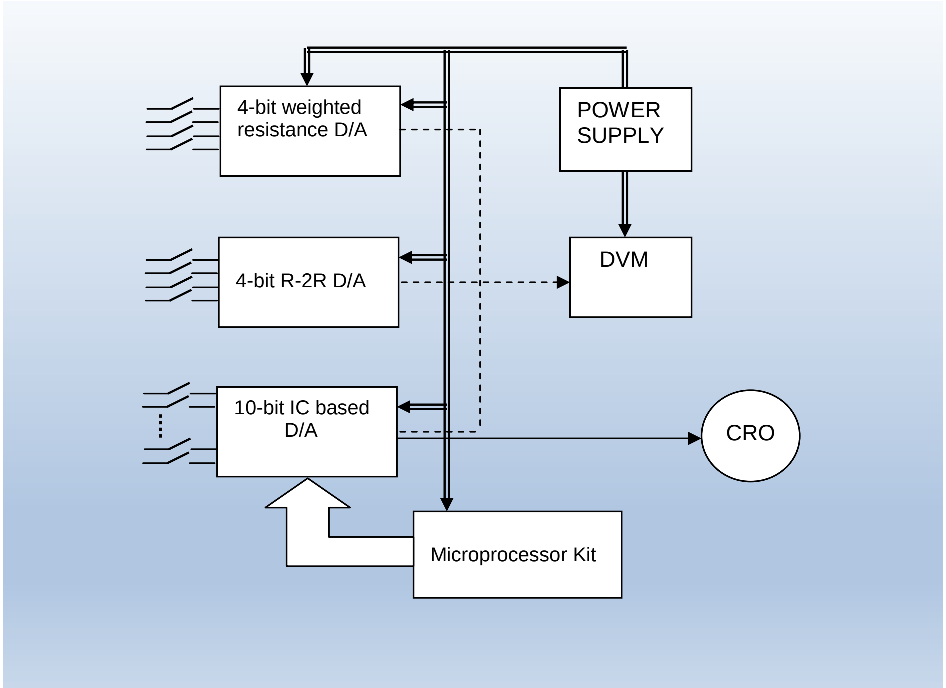
The total unit is supplied with a DVM on the panel for all dc measurements, the necessary power supplies and reference voltage sources for the complete unit, microprocessor unit with sample programs and an exhaustive user manual. No additional equipment, except a general purpose CRO is required for conducting the experiments. The CRO is needed to view the waveforms generated by the microprocessor program.

Experiments



- Study of the circuit diagram and performance of a 4-bit weighted resistance type D/A converter. The digital inputs are to be given by operating four mechanical switches and the output read on the digital panel meter provided.
- The above experiment is conducted on a 4-bit discrete component R-2R network based unit.
- Manual operation of a 10-bit IC D/A converter type AD7533 through 10 mechanical switches. Due to a much better resistance matching in the integrated circuit, the performance is seen to be far superior compared to the discrete 4-bit circuits.
- Operation of the IC based circuit through the microprocessor kit provided. Some typical waveform generation exercises are suggested and solutions are provided. More problems can be attempted by the student with help from his supervisor.

Schematic Diagram



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STROBOSCOPE

STB-01

- Non-contact speed measurement
- High intensity flashes
- Direct speed reading in RPM
- No shaft modification

Introduction

Measurement of the speed of a rotating shaft is a common requirement in many industrial and laboratory applications. Such measurements have usually been carried out in the past with the help of contact type tachometers with friction drive. More recently digital optical non-contact tachometers have been designed which count the reflected pulses from a white patch on the shaft and then display the speed in rpm. The light source is usually a filament lamp operating with dry cells leading to limited life and illumination. A similar idea with magnetic pick-up from a particular area of the shaft has also been used for speed measurement.

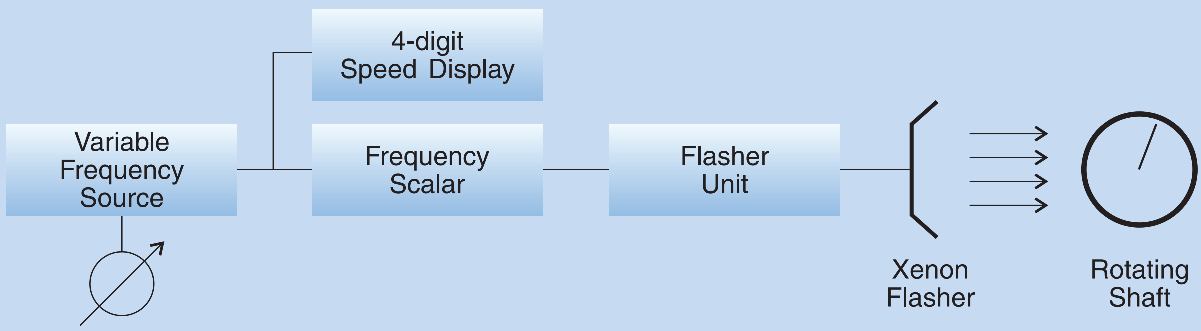
A third category of speed measurement instruments is based on the stroboscope principle. In this a high intensity light flash of a variable frequency is directed towards rotating shaft. Any marking on the shaft appears stationary, if the time of one shaft revolution is a multiple of the flash period. Earlier stroboscopes used neon tubes of low intensity which forced their use close to the rotating shaft.

The present unit has been designed to remove most of the above shortcomings. This has resulted in a good quality, convenient-to-use, direct reading speed measuring instrument. A highly stable function generator IC based circuit provides the basic variable frequency timing pulses. These are read on an IC based 4-digit speed display in rpm. The flasher unit generates the high intensity flashes at a suitably scaled rate directed towards the rotating shaft. A 10 turn potentiometer makes the task of speed setting very precise. Operating instructions are included in the Instruction manual accompanying the unit.

Features and Specifications

- Non-Contact-type - no error due to friction drive, suitable for small motors and also motors in inaccessible locations
- High intensity XENON flashes - operation possible from a reasonable distance (0.5m) in usual ambient light in a room. Detachable lamp unit with 1.5m cable
- 4-digit speed display in rpm - operating range of 500-9900 rpm, resolution 1 rpm. High accuracy crystal controlled LED display
- No shaft modification - Any distinctive existing shaft marking may be used. Alternatively use of stickers or markers is possible
- Power - 220V±10%, 50Hz mains operation. IC regulated internal supplies

Schematic Diagram



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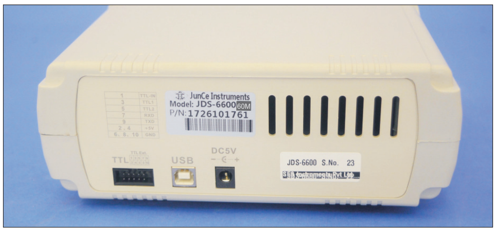
DDS Function Generator

JDS6600

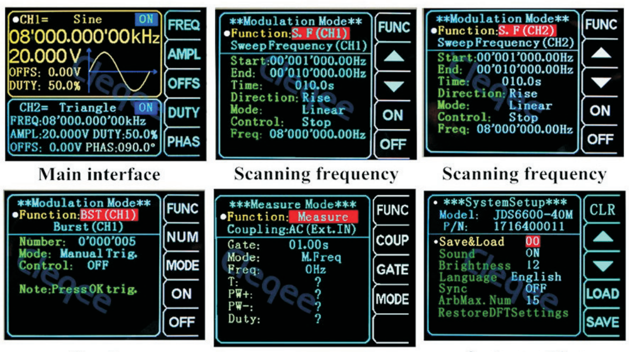
60MHZ Digital Control Dual-channel DDS Function Signal Generator/frequency meter

- 2.4” Color TFT display
- Precise stable, low distortion output
- Dual channel output
- Storage Feature
- Counter function
- USB Insterface
- Aritary waveform editing function



Introduction

JDS6600 is a dual-channel high precision multifunctional signal generator. It adopts large scale of FPGA integrated circuits, high-speed MCU microprocessor and high precision oscillator, which make the signals highly stable. It contains two independent dual-channel DDS signal and TTL level output and is capable of generating sine/triangle/square/sawtooth/pulse wave, white noise, etc. This is a multifunction instrument capable of generating signal, scanning waveform and measuring various electrical parameters. With frequency range of upto 60MHz, it has built-in functions including amplitude modulation and frequency sweep function etc. Output signal amplitude and frequency are continuously displayed. It's a great testing/ measuring instrument for electronics engineers, electronic laboratory, teaching and research.



Main interface

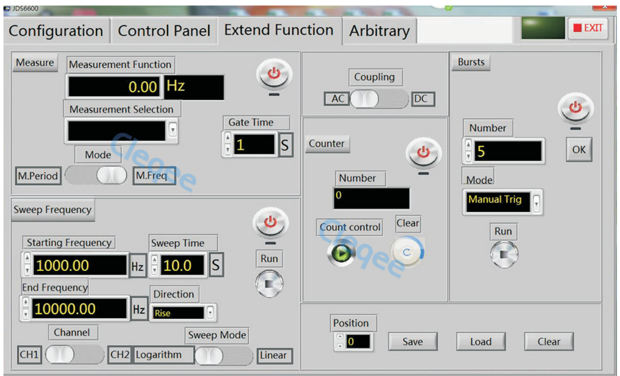
Scanning frequency

Scanning frequency

Bursts

measuring

System settings



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Specifications

Frequency Characteristics

Sine frequency range	: 60MHz
Square/Triangle frequency range	: 60MHz
Pulse frequency range	: 6MHz
Square rise time	: 25nS

Waveform Characteristics

Waveform	: Sine, Square, Triangle, Pulse), Partial Sine, DC level, Half-wave, Full-Wave, Positive Ramp, Negative Ramp, and many other user defined waveforms
Waveform length	: 2048 points
Waveform sampling rate	: 266 MSamples/s
Waveform vertical resolution	: 14 bits

External Measurement Function

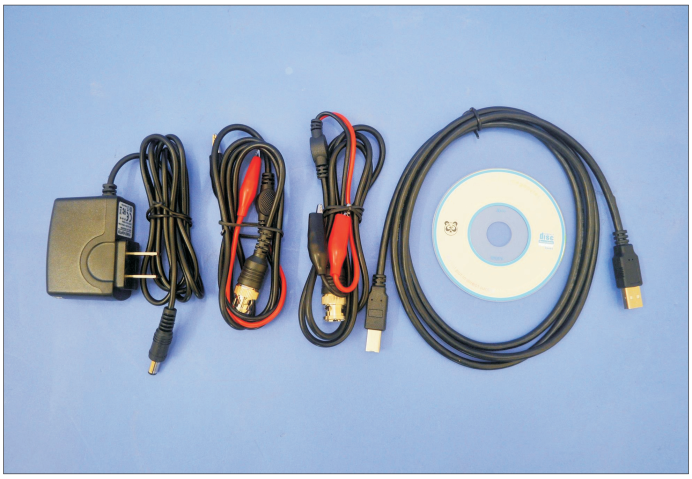
Frequency meter function	: 1Hz-100MHz
Counter function	: 0-4294967295 counts
Input signal voltage range	: 2Vpp-20Vpp
Pulse width measurement	: 0.01us (resolution),
Period measurement	: 20s (max measuring time)

General technical parameters

Display	: 2.4 inch TFT color LCD
Interface	: USB to serial interface
Communication speed	: 115200bps
Communication protocol	: Command-line mode, Open protocol
Power supply voltage	: 5V±0.5V DC
Manufacturing process	: Surface-mount technology, FPGA design, high reliability, long service life

Environmental conditions

Temperature	: 0-40C, Humidity:<80%



Our Team Leaders

Ravi Prakash, Managing Director

Ravi Prakash joined SES Instruments Pvt Ltd. after completing his M.Tech. from IIT Roorkee in 1994. Working under his father, Dr. Anand Prakash, then Managing Director of the company he brought various innovative ideas and was successful in expanding the reach of the company in more than 30 countries. The sales and operations expanded by more than 600% in the last 15 years. A quality culture was developed with less than 0.01% product return rate and less than 0.5% warranty support requirement. He led the company in achieving CE and ISO certification. Appointed as Managing Director in 2009, he focused the company efforts towards R&D helping the company launch more than 8 new products. Expanding the production facility and sales network saw a consistent growth of more than 40% per year.

Dr. R. Mitra, R&D Director

Dr. Mitra obtained his Ph.D. from the University of Roorkee (now IIT Roorkee) in the year 1976. The area of his specialization was Control Systems. His earlier education was from IIT Kharagpur, University of Allahabad and University of Lucknow. Besides post-doctoral work at DFVLR in West Germany , he had been in the faculty of University of Technology, Baghdad and Thapar Institute of Engineering and Technology, Patiala. Since 1970 Dr. Mitra is with the Department of Electronics & Computer Engineering, IIT Roorkee, actively involved in teaching and research in the areas of control systems, electronics, microprocessors and electronic instrumentation. After his retirement he is continuing in the department as an emeritus professor. Association with him for more than 42 years has helped us to develop and bring to perfection most of the experiments listed in this catalog. Besides, our diversification to the area of control system, leading to a dozen experiments, has been solely due to his continuous efforts and support.

Dr. Kailash Chandra, Director Technical

Dr. Kailash Chandra did his M.Sc (Physics) in 1962, Ph.D in 1968 from the University of Roorkee(now IIT-Roorkee) and postdoc at Uppsala University Sweden. His research area was Mossbauer spectroscopy where he himself developed the laboratory from scratch and brought to International level. He joined the faculty of Physics at University of Roorkee in 1967 and rose to Professor and Director in 1980 at University Science Instrumentation Centre (USIC) of University of Roorkee. His main interest has always been experimental Physics and Instrumentation. Towards the later part of his active service he started working in Nanosciece and technology and published more than a dozen research papers. His associations with us have proved very vital in the development of many new equipment and experiments.

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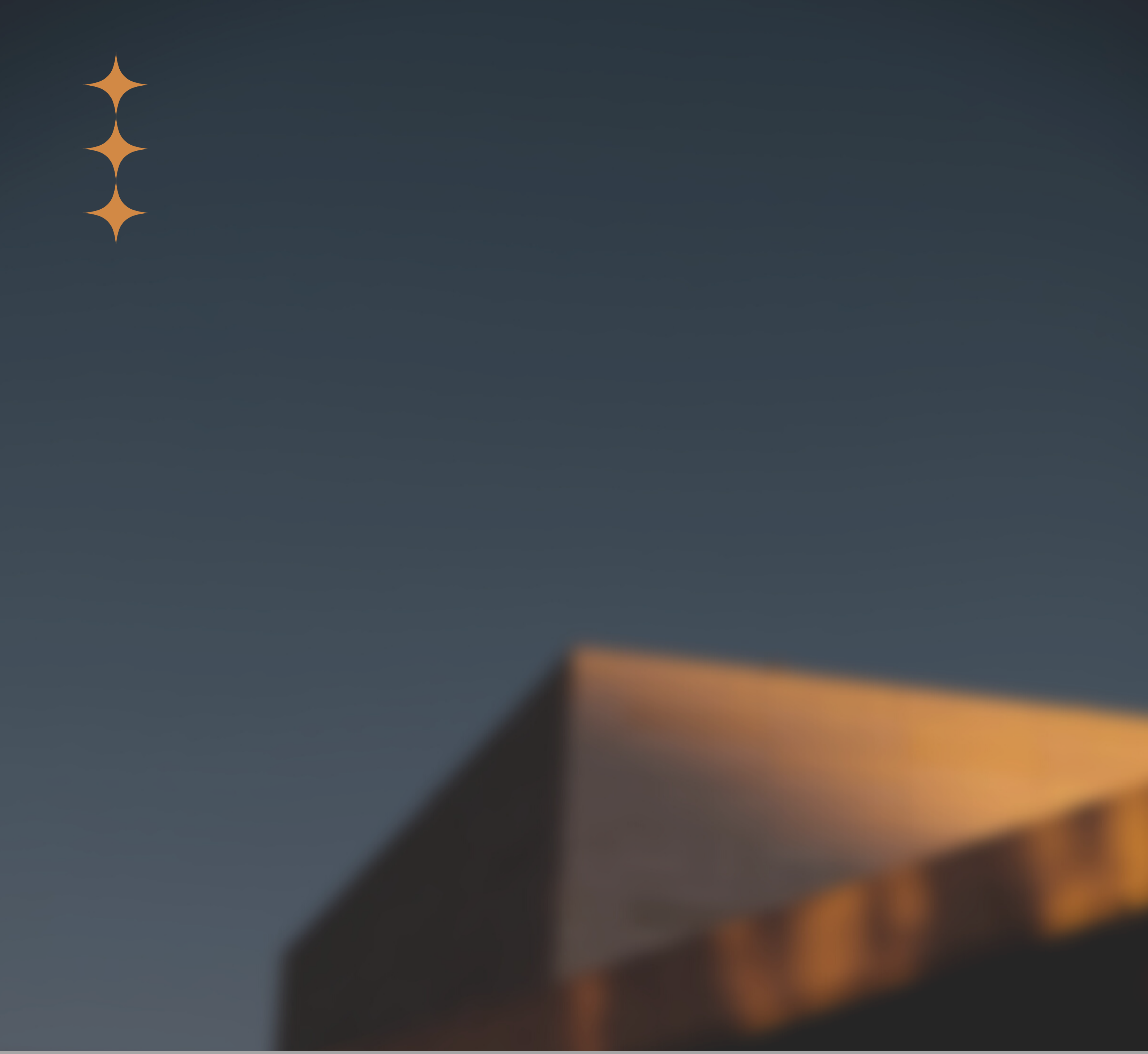

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