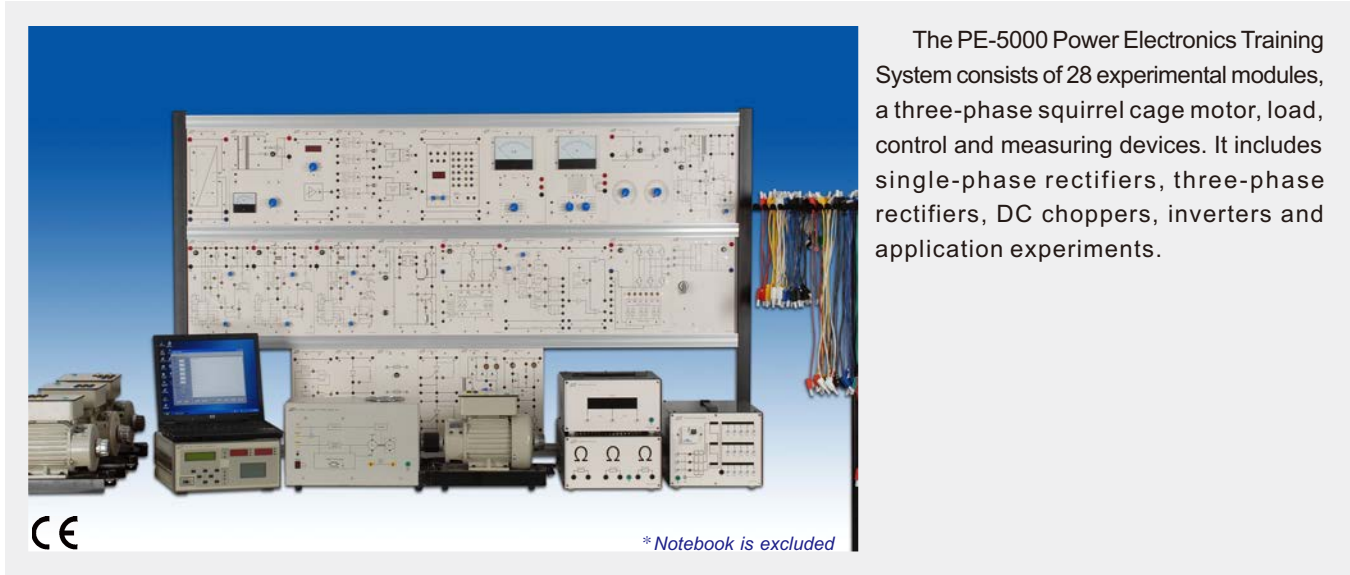




PE-5000

Power Electronics Training System



The PE-5000 Power Electronics Training System consists of 28 experimental modules, a three-phase squirrel cage motor, load, control and measuring devices. It includes single-phase rectifiers, three-phase rectifiers, DC choppers, inverters and application experiments.

► Features

The PE-5000 is the combination of power, electronics and control. It has wide applications of solid-state electronics to the control and conversion of electric power. Popular circuits of power electronics contain rectifiers, choppers and inverters. The experimental modules of PE-5000 include converter, power supply, load, control and testing modules. These experimental modules and instruments are introduced and demonstrated in the subsequent experiments.

► List of Experiments

Chapter 1 :

Basic Measurement and Characteristic of SCR and TRIAC

- 1-1: Three-Phase source voltage measurement
- 1-2: Digital storage oscilloscope and differential amplifier
- 1-3: SCR characteristic and measurement
- 1-4: TRIAC characteristic and measurement

Chapter 2 :

Single-Phase Rectifiers and AC Voltage Controller (AC→DC · AC→AC)

- 2-0: Trigger pulse measurement
- 2-1: Single-Phase Half-Wave uncontrolled rectifier
- 2-2: Single-Phase Full-Wave uncontrolled rectifier
- 2-3: Single-Phase Half-Wave controlled rectifier
- 2-4: Single-Phase Full-Wave controlled rectifier
- 2-5: Symmetrical Single-Phase Full-Wave Semi-Controlled rectifier
- 2-6: Asymmetrical Single-Phase Full-Wave Semi-Controlled rectifier
- 2-7: Single-Phase Semi-Controlled AC voltage controller
- 2-8: Single-Phase Full-Controlled AC voltage controller

Chapter 3 :

Three-Phase Rectifiers and AC Voltage Controller (AC→DC · AC→AC)

- 3-1: Three-Phase Half-Wave uncontrolled rectifier
- 3-2: Three-Phase Full-Wave uncontrolled rectifier
- 3-3: Three-Phase Half-Wave controlled rectifier
- 3-4: Three-Phase Full-Wave Semi-Controlled rectifier
- 3-5: Three-Phase Full-Wave Full-Controlled rectifier
- 3-6: Three-Phase Full-Wave Semi-Controlled AC voltage controller
- 3-7: Three-Phase Full-Wave Full-Controlled AC voltage controller

Chapter 4 :

DC Choppers (DC→DC)

- 4-0: IGBT characteristic measurement
- 4-1: DC PWM controller
- 4-2: Single-Quadrant DC chopper
- 4-3: Two-Quadrant DC chopper
- 4-4: Four-Quadrant DC chopper
- 4-5: SCR DC chopper

Chapter 5 :

Inverters (AC→DC→AC)

- 5-1: Single-Phase PWM controller
- 5-2: Single-Phase inverter
- 5-3: Three-Phase PWM controller
- 5-4: Three-Phase inverter

Chapter 6 :

Applications of Power Electronics

- 6-0: Power MOSFET characteristic measurement
- 6-1: Buck switching power supply
- 6-2: Boost switching power supply
- 6-3: Buck-Boost switching power supply
- 6-4: Flyback switching power supply
- 6-5: Electronic ballast

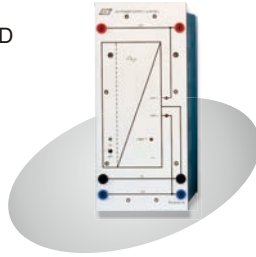


► Specifications

1. PE-5310-1A

DC Power Supply ($\pm 15V/2A$)

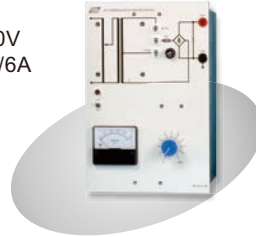
- (1) Short circuit & over temperature protection
- (2) Overcurrent indicator : LED
- (3) Over temperature indicator : LED
- (4) Rated output : $\pm 15V/2A$
- (5) Power indicator : LED
- (6) Operation power supply : AC 220V, 50/60Hz



2. PE-5310-1B

DC Power Supply (0-40V/3A, 0-20V/6A)

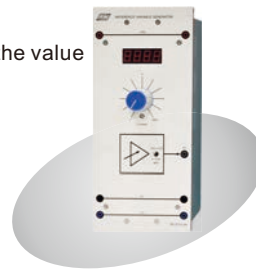
- (1) Input voltage : 220VAC, 50/60Hz
- (2) 2 output voltage : 0~40VDC, 0~20V
- (3) Rated current : 0~40V/3A, 0~20V/6A
- (4) Overload protection



3. PE-5310-2A

Reference Variable Generator

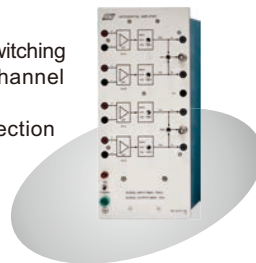
- (1) V_c range : 0V~+10V, -10V~+10V
- (2) Linear scale : 0~100%
- (3) 7-segment display for displaying the value of output control voltage V_c
- (4) Operation power supply : $\pm 15V$



4. PE-5310-2B

Differential Amplifier

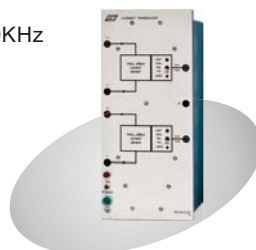
- (1) 4 Channels output and input
- (2) Measuring voltage (Max.) : 700Vp
- (3) Output voltage (Max.) : 10Vp
- (4) Measuring frequency (Max.) : 200KHz
- (5) Input voltage range : 500V, 100V, 10V
- (6) Output voltage range : 10V
- (7) Output terminal : common ground
 - a. 2 BNC sockets for oscilloscope, switching switch to selected measuring channel (A/B, C/D)
 - b. 4 mm terminal for module connection
- (8) Operation power supply : AC 220V, 50/60Hz



5. PE-5310-2C

Current Transducer

- (1) Hall current sensor
- (2) Measuring frequency (Max.) : 200KHz
- (3) Current measuring :
 - a. Input : 20Ap, output 10V
 - b. Input : 5Ap, output 10V
 - c. Input : 1Ap, output 10V
- (4) Overcurrent indicator
- (5) Operation power supply : AC 220V, 50/60Hz



6. PE-5310-2D

Three Phase Angle Controller

- (1) Pulse output : Electric isolation, directly drives up to 6 thyristors
- (2) Trigger angle : 0~180°
- (3) Control input signal : 0~10VDC
- (4) Rectification angle : 0~90° adjustable
- (5) Convert angle : 0~180° adjustable
- (6) Modeselect : Single pulse & continuous pulse
- (7) Operation power supply : $\pm 15V$



7. PE-5310-3A

RMS Meter

- (1) Measuring range :
 - a. Current : 0.1/0.3/1/3/10/30 A
 - b. Voltage : 3/10/30/100/300/1000V
- (2) 3 Measuring types :
 - a. RMS AC+DC : Total RMS value
 - b. RMS AC : Ripple RMS value
 - c. AV AC+DC : Arithmetic mean value
- (3) Overload protection
- (4) \pm Value indicator : LED
- (5) Accuracy : 2%. Full scale
- (6) Operation power supply : AC 220V, 50/60Hz



8. PE-5310-3B

Power Meter (0.3W-30KW)

- (1) Measuring range : 0.3W~30KW
 - a. Current : 0.1/0.3/1/3/10/30 Arms
 - b. Voltage : 3/10/30/100/300/1000V rms
- (2) Frequency range : 0~20KHz
- (3) Overload protection
- (4) Overcurrent & overvoltage LED indicator
- (5) Reactive power \pm value indicator (QL & QC)
- (6) Accuracy : 2% full scale
- (7) Output terminal : Measuring full scale 100%=1V
- (8) Operation power supply : AC 220V, 50/60Hz



9. PE-5310-3C

Resistor Load Unit

- (1) Bench top type
- (2) 3 load resistors, each one 100 Ω
- (3) Rated current : 2.5A
- (4) Rated power : 625W





10. PE-5310-3D

Resistor Load

- (1) 2 resistors load :
 - a. 5~50Ω/120W
 - b. 10~100Ω/120W
- (2) Overcurrent protection



11. PE-5310-3E

Inductive Load Unit

- (1) Bench top type
- (2) Load indicator: 50mH x 2/200mH
- (3) Rated current : 5A



12. PE-5310-4A

Flyback Switching Power Supply

- (1) Test point :
 - a. Switching control IC output signal
 - b. Current feedback signal
 - c. Voltage feedback signal
 - d. Switching power component terminal
- (2) Switching frequency up to 40KHz
- (3) Converter control : Isolation feedback converter
- (4) Input voltage : 95~250V AC
- (5) Output : 45W, up to 80% efficiency
- (6) Output voltage ripple : $\leq 5\%$
- (7) Output voltage regulation : $\leq 5\%$
- (8) Output voltage : DC 12V ~ 15V, adjustable by R18
- (9) Rated current : 2A Max. overload & short circuit protection
- (10) Switching power component : MOSFET



13. PE-5310-4B

Boost Switching Power Supply

- (1) Test point :
 - a. Switching control IC output signal
 - b. Current feedback signal
 - c. Voltage feedback signal
 - d. Switching power component terminal
- (2) Switching frequency : $\geq 40\text{KHz}$
- (3) Input voltage : DC 10 ~ 16V
- (4) Output : 60W, up to 85% efficiency
- (5) Output voltage ripple : $\leq 5\%$
- (6) Output voltage regulation : $\leq 5\%$
- (7) Output voltage : DC 18V ~ 30V, adjustable
- (8) Rated current : 2A Max. overload & short circuit protection
- (9) Switching power component : MOSFET



14. PE-5310-4C

Buck Switching Power Supply

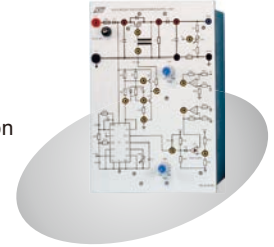
- (1) Test point :
 - a. Switching control IC output signal
 - b. Current feedback signal
 - c. Voltage feedback signal
 - d. Switching power component terminal
- (2) Switching frequency : $\geq 40\text{KHz}$
- (3) Input voltage : DC 17~ 30V
- (4) Output : 45W, up to 85% efficiency
- (5) Output voltage ripple : $\leq 5\%$
- (6) Output voltage regulation : $\leq 5\%$
- (7) Output voltage : DC 10V ~ 15V, adjustable
- (8) Rated current : 2A Max. overload & short circuit protection
- (9) Switching power component : MOSFET



15. PE-5310-4D

Buck-Boost Switching Power Supply

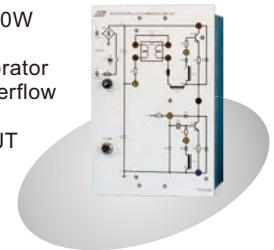
- (1) Test point :
 - a. Switching control IC output signal
 - b. Current feedback signal
 - c. Voltage feedback signal
 - d. Switching power component terminal
- (2) Switching frequency : $\geq 40\text{KHz}$
- (3) Input voltage : DC 20 ~ 30V
- (4) Output : 60W, up to 85% efficiency
- (5) Output voltage ripple : $\leq 5\%$
- (6) Output voltage regulation : $\leq 5\%$
- (7) Output voltage : DC 25V ~ 30V, adjustable
- (8) Rated current : 2A Max. overload & short circuit protection
- (9) Switching power component : MOSFET



16. PE-5310-4E

Electronic Ballast Fluorescent Lamp

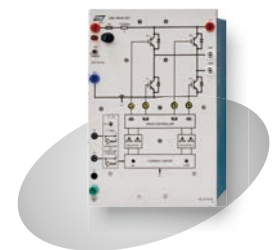
- (1) Switching frequency : 10KHz
- (2) Input voltage range : 220V AC
- (3) Type of lamp : 35cm long tube 10W
- (4) Control mode : half-bridge self-excitation feedback multivibrator
- (5) Output current : 2A max. with overflow and short circuit protection
- (6) Switching power component : BJT



17. PE-5310-4F

IGBT Drive Set

- (1) Input voltage : DC 20~300V
- (2) Output voltage : 20~300Vp
- (3) Drive circuit : Photo couple and drive circuit
- (4) Output device : IGBT, 800V/60A
- (5) Current protector

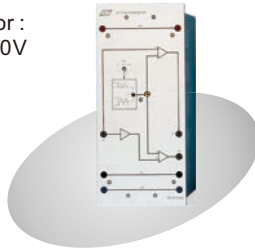




18. PE-5310-4G

DC PWM Generator

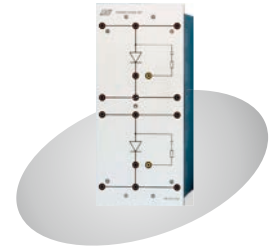
- (1) Triangular wave(carrier) generator :
 - a. Amplitude : 0~10V or -10V~+10V
 - b. Frequency : 1K, 10K, 15KHz
- (2) PWM signal generator :
2 x PWM control signal
- (3) IP input : DC -10V~+10V
- (4) Operation power supply : DC±15V



23. PE-5310-5A

Power Diode Set

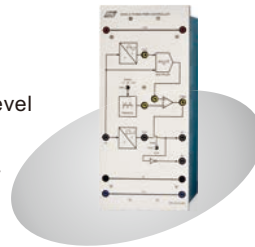
- (1) Rated voltage : 1200V
- (2) Rated current : 40A



19. PE-5310-4H

Single Phase PWM Controller

- (1) Triangular wave(carrier) generator :
 - a. Amplitude : -10V~+10V
 - b. Frequency : 1K, 5K, 15KHz
- (2) Sine wave signal generator
- (3) Multiplex
- (4) PWM Signal generator : 2 x TTL level
- (5) Square wave signal generator
- (6) IP input : DC 0V~+10V
- (7) Operation power supply : DC±15V



24. PE-5310-5B

Fuse Set

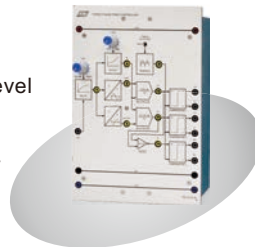
- (1) Module design
- (2) 3 x D-Type fuses, 500V/6A



20. PE-5310-4I

Three Phase PWM Controller

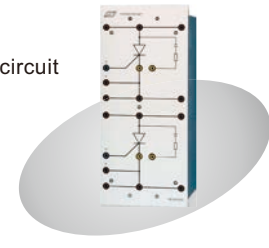
- (1) Triangular wave(carrier) generator :
 - a. Amplitude : -10V~+10V
 - b. Frequency : 5K, 10K, 20KHz
- (2) Sine wave signal generator
- (3) Multiplex
- (4) PWM Signal generator : 6 x TTL level
- (5) Square wave signal generator
- (6) IP input : DC -10V~+10V
- (7) Operation power supply : DC±15V



25. PE-5310-5C

Thyristor (800V/10A)

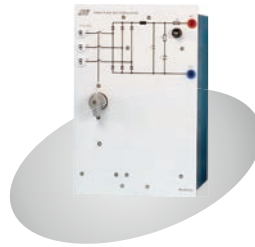
- (1) Rated voltage : 800V
- (2) Rated current : 10A
- (3) With RC surge buffer protection circuit



21. PE-5310-4J

Three Phase Rectifier & Filter

- (1) Power input : 1Ø or 3Ø, 20~220VAC
- (2) With Inductor & capacitor filter circuit
- (3) Surge protection in voltage circuit
- (4) Output voltage :
28~310VDC (max.)/10A(max.)



26. PE-5310-5D

SCR/TRIAC Set

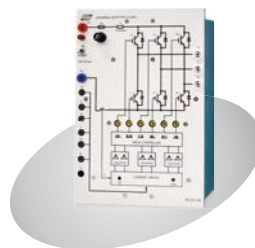
- (1) SCR : 800V/16A
- (2) TRIAC : 600V/12A
- (3) Load lamp : 2 x 24V/10W (with switch)
- (4) Load inductor : 1 x 50m H/1A(with switch)
- (5) With current/voltage transfer measurement
- (6) With trigger control adjustable
- (7) Operation power supply :
AC 220V, 50/60Hz



22. PE-5310-4K

Universal Inverter 3x230V

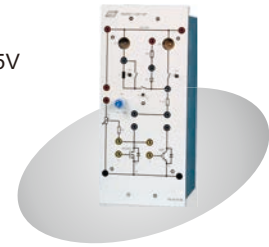
- (1) 6 x TTL level signal input : > 2.5µS, for interlock & dead time control
- (2) Power input : 1Ø or 3Ø, AC 20~220V
- (3) With photo-couple, isolation and main circuit
- (4) Output power component : IGBT 800V/50A
- (5) With adjustable overcurrent protection circuit
- (6) Output capacity : 220V/ 1.5KV
- (7) Operation power supply :
AC 220V, 50/60Hz



27. PE-5310-5E

MOSFET/IGBT Set

- (1) IGBT : 800V/50A
- (2) MOSFET : 100V/48A
- (3) Load lamp : 2 x 24V/10W (with switch)
- (4) Load inductor : 1 x 50mH/1A(with switch)
- (5) With current/voltage transfer measurement
- (6) With trigger control adjustable
- (7) With external signal input
- (8) Operation power supply : DC+15V





28. PE-5310-5F

SCR DC Chopper Set

- (1) Operating voltage : $\pm 15V$, 0.4A
- (2) Input voltage range : 50V~300VDC
- (3) Maximum output current : 5A
- (4) Chopping frequency range : 220~280Hz
- (5) Minimum duty cycle : 0.1
- (6) Maximum duty cycle : 0.8
- (7) External input : DC 0V~10V



29. PE-5340-3A

Isolating Transformer

- (1) Benchtop type
- (2) Output voltage : 3 \emptyset , 4W, Y type connected, 110/164/190/220V line-to-line voltage output
- (3) Rated capacity : 1.5KVA
- (4) Input : AC, 3 \emptyset , 220V, 50/60Hz



30. EM-3340-3B

System Transformer

- (1) Rated power : 1.5KVA
- (2) Primary : Depend on the local line voltage
- (3) Secondary : AC, 3 \emptyset , 220V
- (4) Frequency : 50/60Hz

※ 3-phase power (source) is required while operating this system.

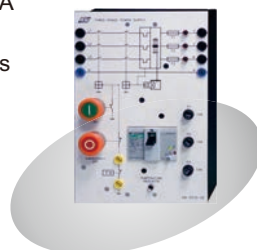
※ The System Transformer EM-3340-3B must be included if 3-phase 220V is not available.



31. EM-3310-1E

Three-phase Power Supply Module

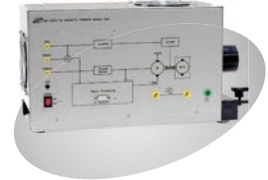
- (1) Modular design
- (2) Overcurrent/leakage protection switch
- (3) Start and emergency power off buttons
- (4) Working voltage : 3 \emptyset 220 Vac, 50/60 Hz
- (5) Rated output : 3 \emptyset 220 Vac/10 A
- (6) Fuse protection
- (7) Terminals : 4mm safety sockets
- (8) Temperature indicator



32. EM-3320-1C

Magnetic Powder Brake Unit

- (1) Power supply : 110/220VAC
- (2) Type : Forced air-cooling magnetic powder brake
- (3) Braking torque : 0.999 kg-m (9.999 N-m), max.
- (4) Speed sensing : Photoelectric type, 60 pulse /rev.
- (5) Torque sensing : Strain-gauge torque transducer, torsion bar
- (6) Temperature sensing : Thermal switch
- (7) Base unit : Integral, aluminum alloy
- (8) Connecting to controller via the dedicated cable
- (9) Cooling fan : 12V DC/0.29A
- (10) Analog DC output :
 - a. Torque output (1V / 1 kg-m)
 - b. Speed output (1V / 1000 rpm)
 - c. Power output (1V / 1 KW)



33. EM-3320-1N

Brake Controller

- (1) Power Supply : 110/220 VAC
- (2) Connecting to magnetic powder brake unit via dedicated cable
- (3) 4-digit 7-segment LED Display : 2 sets
 - a. Display speed (S), torque (T) and power (P) of the motor under test
 - b. Display control voltage (V) and current (I) applied to magnetic powder brake unit
- (4) LCD character display (20x2) & Buttons for command control of entry and display
- (5) LCD graphic display (128x64)
Graphically display characteristics of brake and motor
- (6) Display range :
 - a. Torque : 0 ~ 0.999 kg-m or 0 ~ 9.999 N-m
 - b. Speed : 0 ~ 9999 rpm
 - c. Power : 0 ~ 9.999 KW
 - d. Voltage : 0 ~ 24 V
 - e. Current : 0 ~ 0.999 A
- (7) Control mode :
 - a. Open-loop control mode
Manual on loading and unloading power to brake automatic loading and unloading power, brake selectable initial torque W_i and max torque W_m : 0 ~ 0.999 kg-m
Selectable loading time : 1 ~ 15 sec
 - b. Closed-loop control mode
Constant-torque mode
Constant-speed mode
- (8) Fault detection and indication
 - a. MAIN indicator for controller fault
 - b. BRAKE indicator for brake fault
 - c. MOTOR indicator for motor fault
- (9) Communicating with PC through RS-232 (Standard) or RS-485 (Option) port
- (10) Dedicated hardware and software allow processing and displaying data on PC such as full-screen displaying, tracing, recording, printing motor speed, motor torque, motor power, brake voltage and brake current.



EM-3320-1A (Magnetic Powder Brake Unit) is replaced by EM-3320-1C (Magnetic Powder Brake Unit), and EM-3310-1B (Three-phase Power Supply Module) is replaced by EM-3310-1E (Three-phase Power Supply Module). It is not acceptable to mix and match the old version with the new version.

In other words, EM-3320-1C (Magnetic Powder Brake Unit) + EM-3310-1E (Three-phase Power Supply Module) must be grouped together, EM-3320-1A (Magnetic Powder Brake Unit) + EM-3310-1B (Three-phase Power Supply Module) was the right match.

34. EM-3330-1A

DC Permanent-Magnet Machine

- (1) This machine can be as motor and generator operation.
- (2) Ratings for motor operation
 - a. Rated voltage : 180 Vdc
 - b. Rated current : 2.7 A
 - c. Rated speed : 2500 rpm
 - d. Rated power : 0.4 KW



35. EM-3330-3C

Three-Phase Squirrel Cage Motor

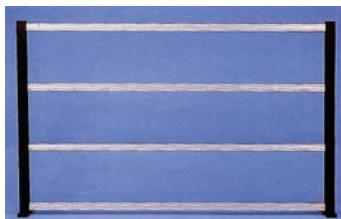
- (1) Rated voltage : Δ 220 Vac , 50/60 Hz
- (2) Rated current : 1.4 A
- (3) Rated speed : 1670 rpm(60 Hz);1420 rpm(50 Hz)
- (4) Rated power : 0.3 KW
- (5) Power factor : 0.82



36. EM-3380-2B

Experimental Frame

- (1) The experimental frame described below is suitable for demonstration with 297 mm high experimental panels.
- (2) The experimental frame can be secured to benches or back uprights and removed at any time.
- (3) The side pieces consist of rectangular tube steel, 60x30x2mm, protected against corrosion. Horizontal sections contains of anodized-aluminum profiles.
- (4) Frame dimension : 1800(W) x 1060(H) x 250(D)mm, $\pm 5\%$



37. EM-3390-2A

Coupling

- (1) Material : Rubber
- (2) Coupling sleeve for mechanical connection between two electrical machines



38. EM-3390-2B

Coupling Guard

- (1) Material : Plate coating
- (2) A guard attachable for contact-proof with electrical machines rotating parts



39. EM-3390-2C

Shaft End Guard

- (1) Material : Plate coating
- (2) A guard attachable to avoid contact with electrical machines rotating parts



40. EM-3390-3A

Connecting Leads Set

- (1) 4mm safety plugs with leads
- (2) Max. rating current : 19A
- (3) Consists of :
 - Connecting leads (25cm), Black/White/Blue/Yellow/Red
 - Connecting leads (50cm), Red/Black/Yellow/Blue/White/Green
 - Connecting leads (100cm), Red/Yellow/Blue/White/Green
 - Connecting leads (150cm), Black/White/Blue/Yellow/Red



41. EM-3390-4A

Safety Bridging Plugs Set

- (1) 4mm safety bridge plugs, 19 mm spacing
- (2) Max. rating current : 19 A
- (3) Consists of :
 - KCN-419A safety bridge plug
 - KCN-419B safety bridge plug



KCN-419A



KCN-419B

42. EM-3380-1A

Laboratory Table (Option)

Dimension : 1800(W) x 900(D) x 780(H)mm, $\pm 5\%$



43. EM-3390-1A

Connecting Lead Holder

- (1) Mobile type with 5-foot tubular steel base and five casters
- (2) Height : 1400mm, iron plate suitable with 20 connecting leads slots.





► Overview of Equipment Required

		Chapter 1	Chapter 2	Chapter 3	Chapter 4	Chapter 5	Chapter 6	Total
1.	PE-5310-1A DC Power Supply ($\pm 15V/2A$)		1	1	1	1	1	1
2.	PE-5310-1B DC Power Supply (0-40V/3A, 0-20V/6A)						1	1
3.	PE-5310-2A Reference Variable Generator		1	1	1	1		1
4.	PE-5310-2B Differential Amplifier	1	1	1	1	1	1	1
5.	PE-5310-2C Current Transducer		1	1	1	1		1
6.	PE-5310-2D Three Phase angle Controller		1	1				1
7.	PE-5310-3A RMS Meter	1	1	1	1	1	1	1
8.	PE-5310-3B Power Meter (0.3W-30KW)		1				1	1
9.	PE-5310-3C Resistor Load Unit		1	1	1	1		1
10.	PE-5310-3D Resistor Load						1	1
11.	PE-5310-3E Inductive Load Unit		1	1	1	1		1
12.	PE-5310-4A Flyback Switching Power Supply						1	1
13.	PE-5310-4B Boost Switching Power Supply						1	1
14.	PE-5310-4C Buck Switching Power Supply						1	1
15.	PE-5310-4D Buck-Boost Switching Power Supply						1	1
16.	PE-5310-4E Electronic Ballast Fluorescent Lamp						1	1
17.	PE-5310-4F IGBT Drive Set				1	1		1
18.	PE-5310-4G DC PWM Generator				1			1
19.	PE-5310-4H Single Phase PWM Controller					1		1
20.	PE-5310-4I Three Phase PWM Controller					1		1
21.	PE-5310-4J Three Phase Rectifier & Filter				1	1		1
22.	PE-5310-4K Universal Inverter 3x230V					1		1
23.	PE-5310-5A Power Diode Set		2	3				3
24.	PE-5310-5B Fuse Set		1	1	1	1		1
25.	PE-5310-5C Thyristor (800V/10A)		2	3				3
26.	PE-5310-5D SCR/TRIAC Set	1						1
27.	PE-5310-5E MOSFET / IGBT Set				1		1	1
28.	PE-5310-5F SCR DC Chopper Set				1			1
29.	PE-5340-3A Isolating Transformer	1	1	1	1	1	1	1
30.	EM-3340-3B System Transformer	1	1	1	1	1	1	1
31.	EM-3310-1E Three-phase Power Supply Module	1	1	1	1	1	1	1
32.	EM-3320-1C Magnetic Powder Brake Unit				1	1		1
33.	EM-3320-1N Brake Controller				1	1		1
34.	EM-3330-1A DC Permanent-magnet machine				1			1
35.	EM-3330-3C Three-phase Squirrel Cage Motor					1		1
36.	EM-3380-2B Experimental Frame	1	1	1	1	1	1	1
37.	EM-3390-2A Coupling				1	1		1
38.	EM-3390-2B Coupling Guard				1	1		1
39.	EM-3390-2C Shaft End Guard				1	1		1
40.	EM-3390-3A Connecting Leads Set	1	1	1	1	1	1	1
41.	EM-3390-4A Safety Bridging Plugs Set	1	1	1	1	1	1	1
42.	EM-3380-1A Laboratory Table (Option)	1	1	1	1	1	1	1
43.	EM-3390-1A Connecting Lead Holder	1	1	1	1	1	1	1

Note : A digital storage oscilloscope is required while doing above experiments which is optional.