Electric Power / Controls

2-kW ELECTRIC POWER TRANSMISSION TRAINING SYSTEMS, SERIES 8059 220 V – 50 Hz VERSION

Shown with optional equipment

GENERAL DESCRIPTION

The Lab-Volt 2-kW Electric Power Transmission Training Systems of the 8059 series are designed to teach through hands-on exercises the principles of transmission of electric power – a subject which is usually taught in a strictly theoretical way.

The exercises show how changes in the source, the load, and the transmission line affect the overall performance of the system. In particular, they illustrate the meaning of active and reactive power, how the voltage at the end of a line can be lowered or raised, how power can be forced to flow over one transmission line instead of another, and how a system behaves when subjected to disturbances. The tests relating to switching transients, sudden overloads, and momentary short-circuits dramatically demonstrate the mechanical swing of generator poles and the concurrent surges of power over the transmission line. More than any amount of theory could show, these exercises convey the meaning of power stability and the limits to power flow.

Alternator, motor, capacitors, reactors, resistors, regulating autotransformer, series compensator, and transmission lines are employed. Despite their small size, these components are designed to act in exactly the same way under steady-state and transient conditions, as their larger counterparts in industry. This practical, hands-on course is presented in a way that is readily

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understandable by anyone who has foundational knowledge of electricity.

The 2-kW Electric Power Transmission Training Systems are available in four versions. Model 8059-2 is a complete system using analog meters to perform the measurements. Model 8059-4 is also a complete system, but it uses a data acquisition interface to perform the measurements. Model 8059-3 is an add-on system to the 2-kW Electromechanical Training System, Model 8013. It provides the equipment to be added to the 8013 to perform the exercises using analog meters. Model 8059-5 is similar to the 8059-3, but it uses a data acquisition interface to perform the measurements.

Courseware

The 2-kW Electric Power Transmission Training System courseware consists of a Student Manual and Instructor Guide. The Student Manual contains exercises designed to present the subject matter in convenient instructional segments. In each exercise, principles and concepts are presented first, followed by a step-by-step, hands-on procedure to complete the learning process. Refer to the Table of Contents of the Student Manual section of this datasheet for a list of the covered topics. The exercises in the Student Manual are written to be performed using the Data Acquisition Interface module. However, for those who are using a system with analog meters, the connection diagrams are included in the Appendix. The Instructor Guide contains the practical results and the answers for each hands-on exercise and review question.

TABLE OF CONTENTS

TABLE OF CONTENTS OF THE STUDENT MANUAL

2-kW Electric Power Transmission System (85279-00)

- Power Measurements
- Voltage Regulation and Power Transmission Capability of a Transmission Line
- Shunt Capacitors and Phase Angle Between Sender and Receiver
- Parameters Affecting Active and Reactive Power Flow
- Power-Handling Capability and Parallel Lines
- Effects of Series Compensation on the Power Transfer Capability and System Stability
- Effect of Series Compensation on the Voltage Regulation and Power Factor
- The Alternator
- The Synchronous Motor
- The Synchronous Compensator and Long High Voltage Lines
- Transmission Line Networks and the Three-Phase Regulating Autotransformer
- The Synchronous Motor Under Load
- Hunting and System Oscillation
- Power System Transients

LIST OF EQUIPMENT

2-kW ELECTRIC POWER TRANSMISSION TRAINING SYSTEM (ANALOG METERS), MODEL 8059-25

QTY	DESCRIPTION	ORDERING NUMBER[1]
1	Mobile Workstation	8110-20[2]
1	Three-Module Workstation	8131-00
2	Three-Phase Transmission Line	8370-05
1	Three-Phase Regulating Autotransformer	8371-05
1	Power Line Series Compensator	8373-05
1	AC Voltmeter	8426-05
1	Phase Meter	8451-30
1	DC Motor/Generator	8501-05
1	Wiring Module for DC Motor/Generator	8502-05
1	Three-Phase Synchronous Motor/Generator	8507-05
1	Wiring Module for Synchronous Motor/Generator	8508-05
3	Resistive Load	8509-05
3	Inductive Load	8510-05
3	Capacitive Load	8511-05
1	DC Voltmeter/Ammeter	8513-05
1	AC Ammeter	8514-05
2	Three-Phase Wattmeter/Varmeter	8515-25
2	Field Rheostat	8524-05
1	Power Supply	8525-25
1	Phase-Shift Indicator	8906-00
1	Stroboscope	8922-15
1	Coupler	8943-00
1	Connection Leads	8952-10
1	2-kW Electric Power Transmission System (Student Manual)	85279-05
1	2-kW Electric Power Transmission System (Instructor Guide)	85279-15

2-kW ELECTRIC POWER TRANSMISSION TRAINING SYSTEM (ADD-ON TO 8013 WITH ANALOG METERS), MODEL 8059-35

QTY	DESCRIPTION	ORDERING NUMBER[1]
2	Three-Phase Transmission Line	8370-05
1	Three-Phase Regulating Autotransformer	8371-05
1	Power Line Series Compensator	8373-05
1	Phase Meter	8451-30
1	Three-Phase Wattmeter	8515-25
1	Phase-Shift Indicator	8906-00
1	Stroboscope	8922-15
1	Connection Leads	8952-A0
1	2-kW Electric Power Transmission System (Student Manual)	85279-05
1	2-kW Electric Power Transmission System (Instructor Guide)	85279-15

[1] The ordering numbers shown apply to the English 220-V version. Other versions are available. Refer to the Ordering Numbers section.

[2] Other workstation models are available. Refer to Model 8110 datasheet.

LIST OF EQUIPMENT (cont'd)

2-kW ELECTRIC POWER TRANSMISSION TRAINING SYSTEM (DATA ACQUISITION), MODEL 8059-45

QTY	DESCRIPTION	ORDERING NUMBER[3]
1	Mobile Workstation	8110-20[4]
1	Three-Module Workstation	8131-00
2	Three-Phase Transmission Line	8370-05
1	Three-Phase Regulating Autotransformer	8371-05
1	Power Line Series Compensator	8373-05
1	DC Motor/Generator	8501-05
1	Wiring Module for DC Motor/Generator	8502-05
1	Three-Phase Synchronous Motor/Generator	8507-05
1	Wiring Module for Synchronous Motor/Generator	8508-05
3	Resistive Load	8509-05
3	Inductive Load	8510-05
3	Capacitive Load	8511-05
2	Field Rheostat	8524-05
1	Power Supply	8525-25
1	Phase-Shift Indicator	8906-00
1	Stroboscope	8922-15
1	Coupler	8943-00
1	Connection Leads	8952-10
1	Data Acquisition and Control Interface	9063-B0
1	2-kW Electric Power Transmission System (Student Manual)	85279-05
1	2-kW Electric Power Transmission System (Instructor Guide)	85279-15

2-kW ELECTRIC POWER TRANSMISSION TRAINING SYSTEM (ADD-ON TO 8013 WITH DATA ACQUISITION), MODEL 8059-55

QTY	DESCRIPTION	ORDERING NUMBER[3]
2	Three-Phase Transmission Line	8370-05
1	Three-Phase Regulating Autotransformer	8371-05
1	Power Line Series Compensator	8373-05
1	Phase-Shift Indicator	8906-00
1	Stroboscope	8922-15
1	Connection Leads	8952-A0
1	Data Acquisition and Control Interface	9063-B0
1	2-kW Electric Power Transmission System (Student Manual)	85279-05
1	2-kW Electric Power Transmission System (Instructor Guide)	85279-15

OPTIONAL EQUIPMENT

QTY	DESCRIPTION	ORDERING NUMBER[3]
1	Three-Phase Transformer	8372-05
1	Power Supply	8525-25

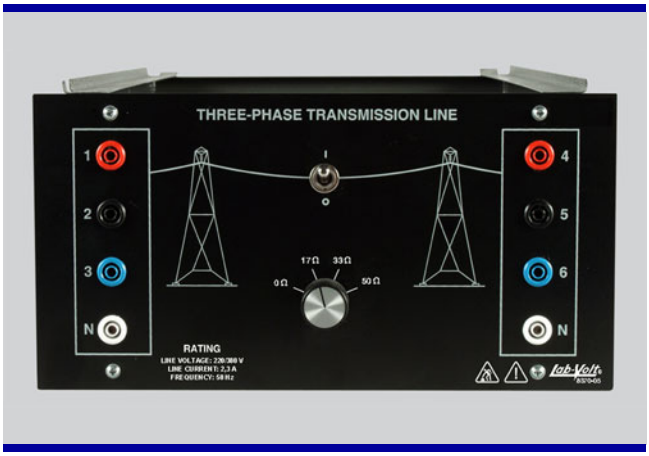
[3] The ordering numbers shown apply to the English 220-V version. Other versions are available. Refer to the Ordering Numbers section.

[4] Other workstation models are available. Refer to Model 8110 datasheet.

MODULE DESCRIPTION

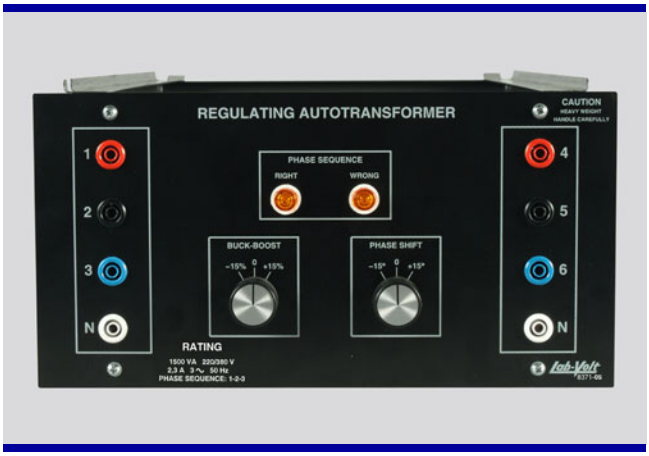
The 2-kW Electric Power Transmission Training System includes exclusive modules that are designed to teach phenomena associated with the generation, transmission, and use of AC electrical power. These exclusive modules are described in this section.

Model 8370 – Three-Phase Transmission Line



The Three-Phase Transmission Line, Model 8370, consists of three iron-core inductors specifically designed to simulate a high-voltage AC transmission line. It is housed in a half-size module. The line impedance can be adjusted to four different values using a selector switch mounted on the front panel. A 3-pole switch is used to induce transients by momentarily interrupting the power flow. “Line” and “load” terminals are accessible through 4-mm color-coded safety sockets.

Model 8371 – Three-Phase Regulating Autotransformer



The Three-Phase Regulating Autotransformer, Model 8371, is housed into a half-size module. It contains three transformers, phase sequence lamps, and buck-boost and phase-shift controls.

The buck-boost control increases or decreases the output voltage of the transformer by 15% of the nominal output voltage. The phase-shift control increases or decreases the secondary output voltage phase angle by 15°.

Since the controls are independent, nine different operational combinations are possible. A phase sequence indicator shows if the three-phase power is properly connected. The phase sequence is 1-2-3 when the RIGHT indicator is on; the phase sequence is 1-3-2 when the WRONG indicator is on. “Line” and “load” terminals are accessible through 4-mm color-coded safety sockets.

Model 8373 – Power Line Series Compensator

The Power Line Series Compensator, Model 8373, is housed in a half-size module. It contains three capacitor banks which can be adjusted to 4 different compensation scales (0, 8.5, 12.5 and 17ohms) using a selector switch. The capacitor banks are accessible through 4-mm color-coded safety sockets.

SPECIFICATIONS

Model 8370 – Three-Phase Transmission Line		**120 V – 60 Hz[5]**	**220 V – 50 Hz**	**240 V – 50 Hz[5]**
Rating	Line Reactance	TBE[6]	0, 17, 33, 50 Ω	TBE
	Line Current	TBE	2,3 A	TBE
Physical Characteristics	Dimensions (H x W x D)	154 x 287 x 440 mm (6,1 x 11,3 x 17,3 in)		
	Net Weight	TBE	23.7 kg (52.2 lb)	TBE
Model 8371 – Three-Phase Regulating Autotransformer		**120 V – 60 Hz**	**220 V – 50 Hz**	**240 V – 50 Hz**
Rating	Line Voltage	TBE	220/380 V	TBE
	Power	TBE	1500 VA	TBE
	Line Current	TBE	2.3 A	TBE
	Buck-Boost Voltage	TBE	-15, 0, +15%	TBE
	Phase-Shift	TBE	-15, 0, +15%	TBE
Physical Characteristics	Dimensions (H x W x D)	154 x 287 x 440 mm (6,1 x 11,3 x 17,3 in)		
	Net Weight	TBE	23.7 kg (52.2 lb)	TBE
Model 8373 – Power Line Series Compensator		**120 V – 60 Hz**	**220 V – 50 Hz**	**240 V – 50 Hz**
Rating	Power Input Voltage	TBE	220 V	TBE
	Power Input Current	TBE	0.5 A	TBE
	Line Voltage	TBE	380 V	TBE
	Line Compensation	TBE	0, 8.5,12.5,17 Ω	TBE
	Line Current	TBE	2.3 A	TBE
Physical Characteristics	Dimensions (H x W x D)	154 x 287 x 440 mm (6,1 x 11,3 x 17,3 in)		
	Net Weight	TBE	6.5 kg (14.4 lb)	TBE

PERSONAL COMPUTER REQUIREMENTS

A Pentium-type personal computer with a USB port, running under one of the following Microsoft® operating systems, Windows® XP, Windows® Vista, or Windows®7, is required.

[5] Contact your Lab-Volt representative for 120 V – 60 Hz and 240 V – 50 Hz versions.

[6] TBE = To be established (Contact your Lab-Volt representative for additional information).

ORDERING NUMBERS

120 V – 60 Hz[7]			220 V – 50 Hz			240 V – 50 Hz[7]
ENGLISH	**FRENCH**	**SPANISH**	**ENGLISH**	**FRENCH**	**SPANISH**	**ENGLISH**
TBE[8]	TBE	TBE	8059-25	8059-26	8059-27	TBE
TBE	TBE	TBE	8059-35	8059-36	8059-37	TBE
TBE	TBE	TBE	8059-45	8059-46	8059-47	TBE
TBE	TBE	TBE	8059-55	8059-56	8059-57	TBE
TBE	TBE	TBE	8110-20	8110-20	8110-20	TBE
TBE	TBE	TBE	8131-00	8131-00	8131-00	TBE
TBE	TBE	TBE	8370-05	8370-06	8370-07	TBE
TBE	TBE	TBE	8371-05	8371-06	8371-07	TBE
TBE	TBE	TBE	8372-05	8372-06	8372-07	TBE
TBE	TBE	TBE	8373-05	8373-06	8373-07	TBE
TBE	TBE	TBE	8426-05	8426-06	8426-07	TBE
TBE	TBE	TBE	8451-30	8451-31	8451-32	TBE
TBE	TBE	TBE	8501-05	8501-05	8501-05	TBE
TBE	TBE	TBE	8502-05	8502-06	8502-07	TBE
TBE	TBE	TBE	8507-05	8507-05	8507-05	TBE
TBE	TBE	TBE	8508-05	8508-06	8508-07	TBE
TBE	TBE	TBE	8509-05	8509-06	8509-07	TBE
TBE	TBE	TBE	8510-05	8510-06	8510-07	TBE
TBE	TBE	TBE	8511-05	8511-06	8511-07	TBE
TBE	TBE	TBE	8513-05	8513-06	8513-07	TBE
TBE	TBE	TBE	8514-05	8514-06	8514-07	TBE
TBE	TBE	TBE	8515-25	8515-26	8515-27	TBE
TBE	TBE	TBE	8524-05	8524-06	8524-07	TBE
TBE	TBE	TBE	8525-25	8525-26	8525-27	TBE
TBE	TBE	TBE	8906-00	8906-00	8906-00	TBE
TBE	TBE	TBE	8922-15	8922-16	8922-17	TBE
TBE	TBE	TBE	8943-00	8943-00	8943-00	TBE
TBE	TBE	TBE	8952-10	8952-10	8952-10	TBE
TBE	TBE	TBE	8952-A0	8952-A0	8952-A0	TBE
TBE	TBE	TBE	9063-B0	9063-B1	9063-B2	TBE
TBE	TBE	TBE	85279-05	TBE	TBE	TBE
TBE	TBE	TBE	85279-15	TBE	TBE	TBE

Table 1. Equipment Ordering Numbers

[7] Contact your Lab-Volt representative for 120 V – 60 Hz and 240 V – 50 Hz versions.

[8] TBE = To be established (Contact your Lab-Volt representative for additional information).

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