

# SYSTEM CONTROL THEORY & APPLICATION WITH HANDS-ON OPERATION



Understanding the operation, maintenance and appropriate trouble response to power system equipment begins with a detailed knowledge of and ability to read and interpret electrical prints. This course is designed to provide the knowledge of the various types of electrical diagrams used in the industry, and to develop the skills necessary to read, draw, and interpret these diagrams. With a basic understanding of diagrams, technicians and engineers are able to develop a logical pattern of troubleshooting that can aid in the successful analysis of systems.

This class presents a logical approach to troubleshooting electrical power systems. Resources for predicting the likelihood of equipment failure will be provided, and a basic program for clearly identifying problems. Common electrical devices and their operational requirements will be discussed. Knowing what is required for their operation, it makes easier to determine what is preventing their correct operation. Diagram analysis for troubleshooting will be practiced.

Using a Hands-On approach will allow the students to transfer the classroom instruction directly to a practical hands-on application. Where each student working in a team will have an integral part to ensuring a safe working environment and demonstrating proper troubleshooting skills.

**Course Duration: 16 hours**

## **INTRODUCTION**

Purpose  
Presentation Methods  
Course Goals

## **BACKGROUND**

History of Electrical Blueprints  
Maps  
Purpose of Electrical Diagrams  
Blueprint Page Layouts

## **SYMBOLS AND TERMS**

ANSI Designations  
IEEE Standards  
Abbreviations  
Device Numbers

## **TYPES OF DIAGRAMS**

Views  
Schematics  
One-Line Diagrams  
Three-Line Diagrams

Interconnect Wiring Diagrams  
PLC Diagrams (Ladder Logic)

## **SYSTEM APPLICATIONS**

Switchgear  
Transformers  
Motors  
UPS & ATS Systems  
Generators (Synchronous & Asynchronous)

## **CONTROL CIRCUITS**

Basic Controls  
Simple Start / Stop Circuit  
Dual Control Circuit  
Time Delayed Operation  
Complete Control Circuits

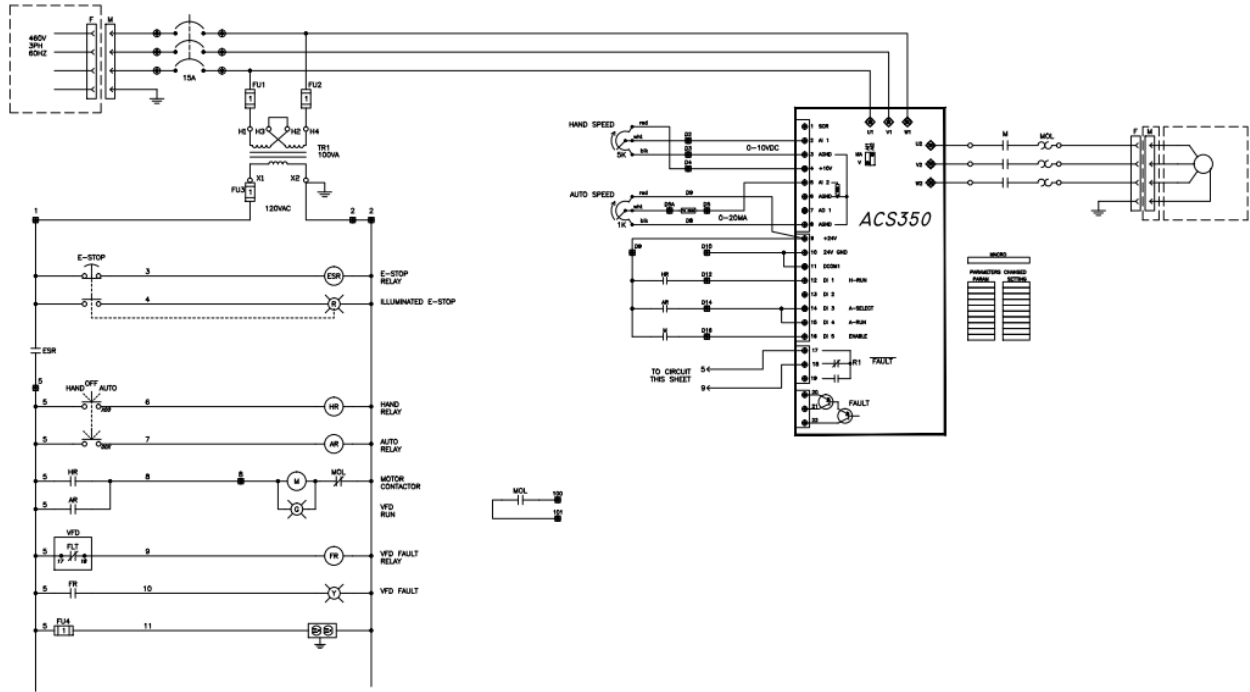
## **SAFETY**

Qualified and Unqualified Persons  
Diagram Safety



# O'DWYER

TECHNICAL SERVICES  
Measurable Goals ... Exceeding Expectations



# O'Dwyer Technical Services, LLC Terms and Conditions

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1. **PRICES:** Unless otherwise specified in writing by Seller, the price quoted or specified by Seller for the Services shall remain in effect for ninety (90) days after the date of Seller's quotation, Seller's scope of work or acknowledgment of Buyer's order for the Services, whichever occurs first, provided an unconditional authorization from Buyer for the performance of the Services is received and accepted by Seller within such time period. If authorization is not received by Seller within such ninety (90) day period, Seller shall have the right to change the price for the Services. All prices are exclusive of taxes, which are to be borne by Buyer. Unless otherwise specified by Seller, Parts will be furnished at Seller's then prevailing prices.

2. **TAXES:** Any current or future tax or governmental charge (or increase in same) affecting Seller's costs of Services or costs of production, sale, delivery or shipment of Parts, or which Seller is otherwise required to pay or collect in connection with the provision of Services and Parts, shall be for Buyer's account and shall be added to the price or billed to Buyer separately, at Seller's election.

3. **TERMS OF PAYMENT:** Buyer shall be billed monthly, Seller, at its discretion, may require monthly progress payments for services requiring more than thirty (30) days to complete. Terms of payment are net 30 days from date of Seller's invoice. Seller shall have the right, among other remedies, either to terminate this Agreement or to suspend further performance under this Agreement and/or other agreements with Buyer in the event Buyer fails to make any payment when due, which other agreements Buyer and Seller hereby amend accordingly. Buyer shall be liable for all expenses, including attorneys' fees, relating to the collection of past due amounts. If any payment owed to Seller is not paid when due, it shall bear interest, at a rate to be determined by Seller, which shall not exceed the maximum rate permitted by law, from the date on which it is due until it is paid. Seller may preserve its interests in payment by enforcing any applicable mechanic's, construction or similar lien rights. Should Buyer's financial responsibility become unsatisfactory to Seller, cash payments or security satisfactory to Seller may be required by Seller for future performance of Services or provision of Parts. If such cash payment or security is not provided, in addition to Seller's other rights and remedies, Seller may discontinue performance of Services and provision of Parts.

4. **SHIPMENT AND DELIVERY:** While Seller will use all reasonable commercial efforts to maintain the performance dates acknowledged or quoted by Seller, all performance dates are approximate and not guaranteed. Seller, at its option, shall not be bound to tender delivery of any Parts for which Buyer has not provided shipping instructions and other required information. If the provision of Services or shipment of the Parts is postponed or delayed by Buyer for any reason, Buyer agrees to reimburse Seller for any and all storage costs and other additional expenses resulting therefrom.

5. **LIMITED WARRANTY:** Seller warrants to Buyer that the Services will be performed by trained personnel using proper equipment and instrumentation for the particular service. Seller warrants that any analysis of data, subsequent recommendations and other services will be in accordance with applicable established industry standards and practices. Seller warrants the proper performance of the Services for a period of ninety (90) days from the completion of the Services. Warranties applicable to third party equipment, parts or materials furnished by Seller shall be that of the manufacturer of such Parts and only to the extent assignable to Buyer. EXCEPT AS SPECIFIED ABOVE, THIRD PARTY SERVICES AND/OR PARTS ARE FURNISHED AS-IS, WHERE-IS, WITH NO WARRANTY WHATSOEVER. THE WARRANTY SET FORTH IN THIS SECTION IS THE SOLE AND EXCLUSIVE WARRANTY GIVEN BY SELLER WITH RESPECT TO THE SERVICES AND PARTS AND IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, ARISING BY OPERATION OF LAW OR OTHERWISE, INCLUDING WITHOUT LIMITATION, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WHETHER OR NOT THE PURPOSE OR USE HAS BEEN DISCLOSED TO SELLER IN SPECIFICATIONS, DRAWINGS OR OTHERWISE.

This warranty does not extend to any losses or damages due to misuse, accident, abuse, neglect, normal wear and tear, negligence (other than Seller's), unauthorized modification or alteration, use beyond rated capacity, unsuitable power sources or environmental conditions, improper installation, repair, handling, maintenance or application or any other cause not the fault of Seller. To the extent that Buyer or its agents have supplied specifications, information, representation of operating conditions or other data to Seller that is used in (i) the selection of the Services and/or Parts and (ii) the preparation of Seller's quotation and/or scope of work, and in the event that actual operating conditions or other conditions differ from those represented by Buyer, any warranties or other provisions contained herein that are affected by such conditions shall be null and void.

If within thirty (30) days after Buyer's discovery of any warranty defects within the warranty period, Buyer notifies Seller thereof in writing, Seller shall, at its option, repair, correct or replace F.O.B. point of manufacture, or refund the purchase price for, that portion of the services or equipment found by Seller to be defective. Failure by Buyer to give such written notice within the applicable time period shall be deemed an absolute and unconditional waiver of Buyer's claim for such defects. Equipment repaired or replaced during the warranty period shall be covered by the foregoing warranties for the remainder of the original warranty period or thirty (30) days from the date of shipment, whichever is longer.

Buyer assumes all other responsibility for any loss, damage, or injury to persons or property arising out of, connected with, or resulting from the use of Services or Parts, either alone or in combination with other parts.

6. **LIMITATION OF REMEDY AND LIABILITY:** THE SOLE AND EXCLUSIVE REMEDY FOR BREACH OF ANY WARRANTY HEREUNDER (SHALL BE LIMITED TO, AT SELLER'S SOLE OPTION, EITHER CORRECT PERFORMANCE FOR THAT PORTION OF THE SERVICES FOUND BY SELLER TO BE DEFECTIVE OR REFUND OF THE PRICE PAID FOR SERVICES.

SELLER SHALL NOT BE LIABLE FOR DAMAGES CAUSED BY DELAY IN PERFORMANCE AND THE REMEDIES OF BUYER SET FORTH IN THIS AGREEMENT ARE EXCLUSIVE. IN NO EVENT, REGARDLESS OF THE FORM OF THE CLAIM OR CAUSE OF ACTION (WHETHER BASED IN CONTRACT, INFRINGEMENT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE), SHALL SELLER'S LIABILITY TO BUYER AND/OR ITS CUSTOMERS EXCEED THE PRICE PAID BY BUYER FOR THE SPECIFIC SERVICES OR PARTS PROVIDED BY SELLER GIVING RISE TO THE CLAIM OR CAUSE OF ACTION.

BUYER AGREES THAT SELLER'S LIABILITY TO BUYER AND/OR ITS CUSTOMERS SHALL NOT EXTEND TO INCLUDE INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES. The term "consequential damages" shall include, but not be limited to, loss of anticipated profits, business interruption, loss of use, revenue, reputation and data, costs incurred, including without limitation, for capital, fuel, power and loss or damage to property or equipment.

Buyer expressly acknowledges and agrees that Seller has set its prices and entered into this Agreement in reliance upon the limitations of liability and other terms and conditions specified herein, which allocate the risk between Seller and Buyer and form a basis of this bargain between the parties. It is expressly understood that any technical advice furnished by Seller with respect to the use of the Parts and/or Services is given without charge, and Seller assumes no obligation or liability for the advice given, or results obtained, all such advice being given and accepted at Buyer's risk.

7. **EXCUSE OF PERFORMANCE:** Seller shall not be liable for delays in performance or for non-performance due to acts of God; war; epidemic; fire; flood; weather; sabotage; strikes or labor disputes; civil disturbances or riots; governmental requests, restrictions, allocations, laws, regulations, orders or actions; unavailability of or delays in transportation; default of suppliers; or unforeseen circumstances; acts or omissions of Buyer, including, without limitation, those specified in Section 19; or any events or causes beyond Seller's reasonable control. Performance of Services and deliveries of Parts may be suspended for an appropriate period of time or canceled by Seller upon notice to Buyer in the event of any of the foregoing, but the balance of this Agreement shall otherwise remain unaffected as a result of the foregoing. If Seller determines that its ability to supply the total demand for the Services or Parts or to obtain material used directly or indirectly in the manufacture of the Parts is hindered, limited or made impracticable due to causes set forth in the preceding paragraph, Seller may delay performance of Services or allocate its available supply of the Parts among its purchasers on such basis as Seller determines to be equitable without liability for any failure of performance which may result therefrom.

8. **CANCELLATION:** Buyer may cancel orders only upon reasonable advance written notice and upon payment to Seller of Seller's cancellation charges which include, among other things, all costs and expenses incurred and to cover commitments made by the Seller, and a reasonable profit thereon. Seller's determination of such cancellation charges shall be conclusive.

9. **CHANGES:** Buyer may request changes or additions to the Services. In the event such changes or additions are accepted by Seller, Seller may revise the price and performance dates. Seller reserves the right to change designs and specifications for the Parts without prior notice to Buyer, except with respect to Parts being made-to-order for Buyer. Seller shall have no obligation to install or make such change in any Parts manufactured prior to the date of such change.

10. **NUCLEAR/MEDICAL:** SERVICES AND PARTS SOLD HEREUNDER ARE NOT FOR USE IN CONNECTION WITH ANY NUCLEAR, LIFE-SUPPORT AND RELATED APPLICATIONS. Buyer accepts Services and Parts with the foregoing understanding, agrees to communicate the same in writing to any subsequent purchasers or users and to defend, indemnify and hold harmless Seller from any claims, losses, suits, judgments and damages, including incidental and consequential damages, arising from such use, whether the cause of action be based in tort, contract or otherwise, including allegations that the Seller's liability is based on negligence or strict liability.

11. **ASSIGNMENT:** Buyer shall not assign its rights or delegate its duties hereunder or any interest herein without the prior written consent of Seller, and any such assignment or delegation, without such consent, shall be void.

12. **INSPECTION:** Buyer shall have ten (10) days from the date of completion of each portion of the Services to inspect the Services, and in the event of any non-conformity, Buyer must give written notice to Seller within said period stating why the Services are not conforming. Failure by Buyer to give such notice constitutes unqualified acceptance of the Services.

13. **BILLABLE SERVICES:** Additional charges will be billed to Buyer at Seller's then prevailing labor rates for any of the following: a) any Services not specified in Seller's quotation, Seller's order acknowledgment, Seller's scope of work, or other documents referenced herein and therein; b) any Services performed at times other than Seller's normal service hours; c) if timely and reasonable site and/or equipment access is denied the Seller service representative; d) if it is necessary, due to local circumstances, to use union labor or hire an outside contractor, Seller Service personnel will provide supervision only and the cost of such union or contract labor will be charged to Buyer; or e) Seller's performance is made more burdensome or costly as a result of Buyer's failure to comply with its obligations herein.

14. **NON-SOLICITATION:** Buyer shall not solicit, directly or indirectly, or employ any employee of Seller during the period any Services are being provided to Buyer and for a period of one (1) year after the last provision of Services. In the event that an employee of Seller is hired or leaves the employ of Seller in such circumstances, the Buyer shall pay Seller, as compensation for the cost incurred by Seller in recruiting and training the employee, the sum equivalent to six (6) months pay for each employee hired from or leaving the employment of Seller.

15. **GENERAL PROVISIONS:** These Services Terms and Conditions supersede all other communications, negotiations and prior oral or written statements regarding the subject matter of these Services Terms and Conditions. No change, modification, rescission, discharge, abandonment, or waiver of these Services Terms and Conditions shall be binding upon the Seller unless made in writing and signed on its behalf by a duly authorized representative of Seller. No conditions, usage of trade, course of dealing or performance, understanding or agreement purporting to modify, vary, explain, or supplement this Agreement shall be binding unless hereafter made in writing and signed by the party to be bound, and no modification or additional terms shall be applicable to this Agreement by Seller's receipt, acknowledgment, or acceptance of purchase orders, shipping instruction forms, or other documentation containing terms at variance with or in addition to those set forth herein. Any such modifications or additional terms are specifically rejected and deemed a material alteration hereof. If this document shall be deemed an acceptance of a prior offer by Buyer, such acceptance is expressly conditional upon Buyer's assent to any additional or different terms set forth herein. Seller reserves the right to subcontract Services to others. No waiver by either party with respect to any breach or default or of any right or remedy, and no course of dealing, shall be deemed to constitute a continuing waiver of any other breach or default or of any other right or remedy, unless such waiver be expressed in writing and signed by the party to be bound. All typographical or clerical errors made by Seller in any quotation, acknowledgment or publication are subject to correction.

The validity, performance, and all other matters relating to the interpretation and effect of this Agreement shall be governed by the law of the state of Ohio without regard to its conflict of laws principles. Buyer and Seller agree that the proper venue for all actions arising in connection herewith shall be only in the county of Franklin, state of Ohio, and the parties agree to submit to such jurisdiction. No action, regardless of form, arising out of transactions relating to this contract, may be brought by either party more than two (2) years after the cause of action has accrued. The U.N. Convention on Contracts for the International Sales of Goods shall not apply to this Agreement.

16. **ADDITIONAL SERVICE CONDITIONS:** The Buyer shall furnish to Seller, at no cost, suitable working space, storage space, adequate heat, telephone, light, ventilation, regulated electric power and outlets for testing purposes. The facilities shall be within a reasonable distance from where the Services are to be provided. Seller and its representatives shall have full and free access to the equipment in order to provide the necessary Services. Buyer shall provide the means to shut-off and secure electric power to the equipment and provide safe working conditions. Buyer shall not require Seller or its employees, as a condition to site access or otherwise, to further agree or enter into any agreement, which waives, releases, indemnifies or otherwise limits or expands any rights or obligations whatsoever. Any such agreements shall be null and void. Seller is under no obligation to remove or dispose of Parts or equipment unless specifically agreed upon in Seller's scope of work. Seller removed Parts become the property of Seller. Seller shall not perform any electrical power switching unless specifically requested by Buyer, under the supervision of the Buyer, and subject to procedures jointly agreed to in advance. Notwithstanding Buyer's request, Seller may refuse to perform power switching, if in the opinion of Seller, such action would be unsafe. IN THE EVENT THAT SELLER PERFORMS POWER SWITCHING, TO THE FULLEST EXTENT PERMITTED BY LAW, BUYER SHALL INDEMNIFY, DEFEND, AND HOLD SELLER HARMLESS FROM ANY AND ALL LIABILITY, ACTIONS, SUITS, CLAIMS, DEMANDS, DAMAGES, COSTS, AND EXPENSES ("LOSSES") ARISING OUT OF OR IN ANY WAY CONNECTED WITH OR RESULTING FROM SELLER'S PERFORMANCE OF POWER SWITCHING, REGARDLESS OF WHETHER THE LOSSES RESULT FROM SELLER'S NEGLIGENCE (WHETHER ACTIVE OR PASSIVE, AND WHETHER SOLE, JOINT, OR CONCURRENT), AND EVEN THOUGH CAUSED IN WHOLE OR IN PART BY A PRE-EXISTING DEFECT, STRICT LIABILITY, OR OTHER LEGAL FAULT OF SELLER. THIS INDEMNITY SHALL APPLY TO ANY ACTS OR OMISSIONS OR NEGLIGENT CONDUCT, WHETHER ACTIVE OR PASSIVE, ON THE PART OF EITHER THE SELLER OR THE BUYER. If OSHA or any other federal, state or local government, trade association, or contractual regulations or standards require a "safety person" to be on site during the performance of services, or in the event of a trade union jurisdictional dispute where trade union represented personnel are required to assist or stand by during the performance of services by Seller, Buyer shall be responsible for providing for and paying for any charge or wages for such person(s), as applicable. Buyer shall immediately inform Seller, in writing, at the time of order placement and thereafter, of any unsafe or hazardous substance or condition at the site, including, but not limited to, the presence of asbestos or asbestos-containing materials, and shall provide Seller with any applicable Material Data Safety Sheets regarding the same. Any losses, costs, damages, claims and expenses incurred by Seller as a result of Buyer's failure to so advise Seller shall be borne by Buyer. Seller, in its sole discretion and without cost or penalty, reserves the right to cancel its performance under this Agreement or any order immediately upon written notice to Buyer following Seller discovery of unsafe or hazardous site substance or condition or any other circumstance altering Seller performance of Services. Buyer shall appoint a representative familiar with the site and the nature of the Services to be performed by Seller to be accessible at all times that Seller personnel are at the site. Seller shall not be liable for any expenses incurred by Buyer in removing, replacing or refurbishing any Buyer equipment or any part of Buyer's building structure that restricts Seller access. Buyer personnel shall cooperate with and provide all necessary assistance to Seller. Seller shall not be liable or responsible for any work performed by Buyer.

17. **INSURANCE:** Seller shall maintain the following insurance or self-insurance coverage: **Worker's Compensation** in accordance with the statutory requirements of the state in which the work is performed. **Employer's Liability** with a limit of liability of \$1,000,000 per occurrence for bodily injury by accident or bodily injury by disease. **Commercial General Liability (CGL)** for bodily injury and property damage with a limit of \$1,000,000 per occurrence and aggregate. CGL includes Contractual Liability. CGL does not include Products and Completed Operations coverage. **Automobile Liability** insurance that covers usage of all owned, non-owned and leased vehicles and which is subject to a combined single limit per occurrence of \$1,000,000. Automobile Liability insurance includes Contractual Liability and Cross Liability, but no special endorsements.

18. **INDEMNITY:** Each party shall indemnify and hold the other party harmless from loss, damage, liability or expense resulting from damage to personal property of a third party, or injuries, including death, to third parties to the extent caused by a negligent act or omission of the party providing indemnification or a party's subcontractors, agents or employees during performance of services hereunder. Such indemnification shall be reduced to the extent damage or injuries are attributable to others. The indemnifying party shall defend the other party in accordance with and to the extent of the above indemnification, provided that the indemnifying party is: i) promptly notified by the other party, in writing, of any claims, demands or suits for such damages or injuries; ii) given all reasonable information and assistance by the other party; iii) given full control over any resulting negotiation, arbitration or litigation, including the right to choose counsel and settle claims, or the indemnifying party's obligations herein shall be deemed waived.