DC Analog Output Modules
for
DM Series Power Meters

User's Manual
Revision 7

October 25, 2000

Doc #: E104-7-03-07

Electro Industries/GaugeTech
1800 Shames Drive Westbury, New York 11590
Tel: (516) 334-0870 Fax: (516) 338-4741
Email: sales@electroind.com Website: www.electroind.com

Electro Industries/Gaugetech
Division of E. I. Electronics, Inc.
1800 Shames Drive Westbury, New York 11590 U. S. A
Tel: 516-334-0870 Fax: 516-338-4741
Email: sales@electronind.com Website: www.electroind.com

Customer or Technical Assistance, Repair and Calibration

Customer support is available 9:00 A.M. to 4:30 P.M., Eastern Time, Monday through Friday. Please have the model, serial number and a detailed problem description available. If the problem concerns a particular reading, please have **all** meter readings available. When returning any merchandise to E.I.G., a return authorization number is required.

PRODUCT WARRANTY:	Electro Industries/Gaugetech warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment. During the warranty period, we will, at our option, either repair or replace any product that proves to be defective. To exercise this warranty, fax or call our customer service department. You will receive prompt assistance and return instructions. Send the instrument, transportation prepaid, to the address above. Repairs will be made and the instrument will be returned.
LIMITATION OF WARRANTY:	This warranty does not apply to defects resulting from unauthorized modification, misuse, use for any reason other than electrical power monitoring. This unit is not to be used for primary over current protection. Any protection feature in this unit is to be used for alarm or secondary protection only. **This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for a particular purpose. Electro Industries/Gaugetech shall not be liable for any indirect, special or consequential damages arising from any authorized or unauthorized use of any Electro Industries / Gaugetech product.**
STATEMENT OF CALIBRATION:	This instrument has been inspected and tested in accordance with specifications published by Electro Industries/Gaugetech. The accuracy and calibration of this instrument are traceable to the National Bureau of Standards through equipment which is calibrated at planned intervals by comparison to certified standards.
DISCLAIMER:	Information presented in this publication has been carefully checked for reliability; however, no responsibility is assumed for inaccuracies. The information contained in this document is subject to change without notice.
COPYRIGHT:	No part of this manual may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or information storage or retrieval systems or any future forms of duplication, for any purpose other than the purchaser's use, without the expressed written permission of Electro Industries/Gaugetech, division of E. I. Electronics, Inc.

Copyright (C) 2000 Electro Industries/Gaugetech. Division of E. I. Electronics, Inc. All rights reserved.
Printed in the United States of America.

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

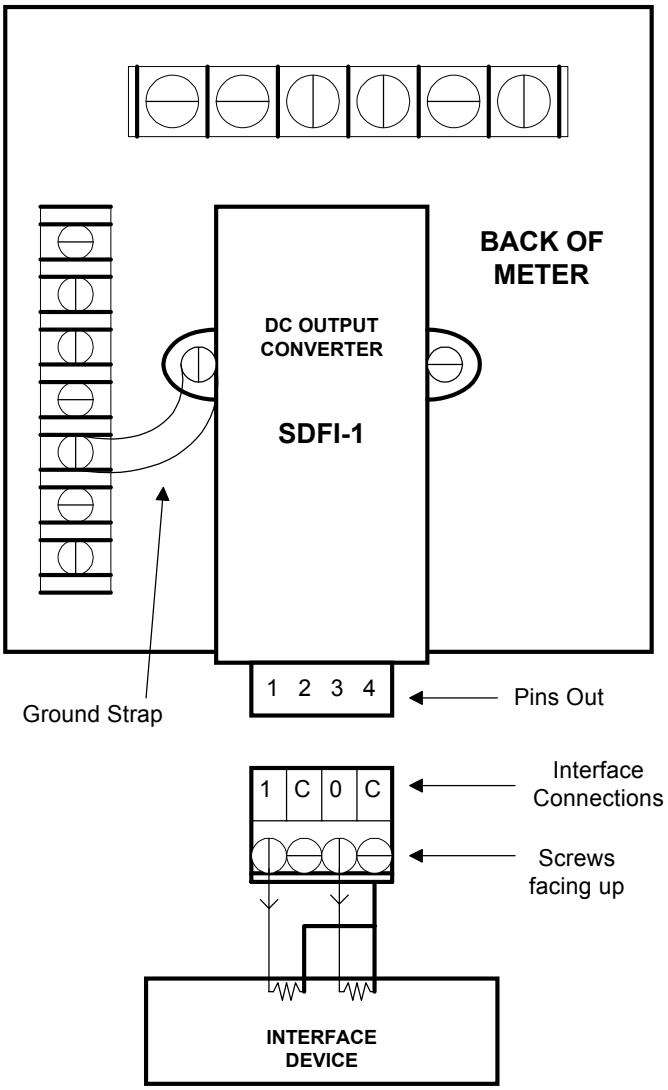
CHAPTER 1
INTRODUCTION & INSTALLATION

1.1: Introduction

Electro Industries manufactures electrical monitoring products that measure every aspect of power, using both digital and analog communication. The DM Series Analog Output Modules (also called transducer output modules) convert the digitally sampled readings to a proportional 0-1mA or 4-20mA DC signal. The analog modules produce a DC current output proportional to the primary readings, but are completely isolated from the primary voltages and/or currents.

Analog transducer outputs are widely used in the field to bring back signals to central collection locations for the purpose of control, data acquisition, alarm or protection. The Electro Industries Analog Output Modules provide these DC signals, replacing the need for discreet transducers for telemetry.

Figure 1.1: Schematic of an SDFI-1 DC Analog Output Converter mounted on a meter.



1.2: Mechanical Installation

The DC Analog Output Modules have a label on one side, the Front side, and an eight-pin connector on the Backside. Mechanical Installation is accomplished by inserting the eight-pin connector into the meter's Port Socket. (For Electrical Installation, see Chapter 2.) The Mechanical Installation steps are:

- **Carefully** remove the two flat head slotted screws on the back of the meter.
- Insert the eight-pin connector into the Port Socket.
- Secure the module with the same two slotted screws. Because these screws are used to secure the meter back in place as well as the module, **caution** should be used when removing them and reinserting them.
- Be sure to reconnect the **GROUND STRAP** under one of the screws. This strap is essential for the correct operation and safety of the meter.

NOTE: The SHNI Model requires an additional External DC Output Module (see Figure 1.3).

Figure 1.2: DC Analog Installation

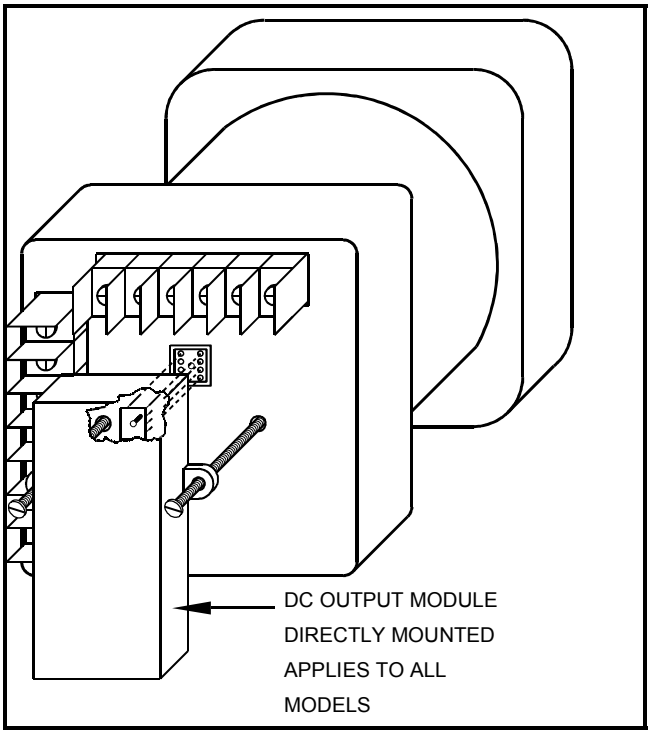
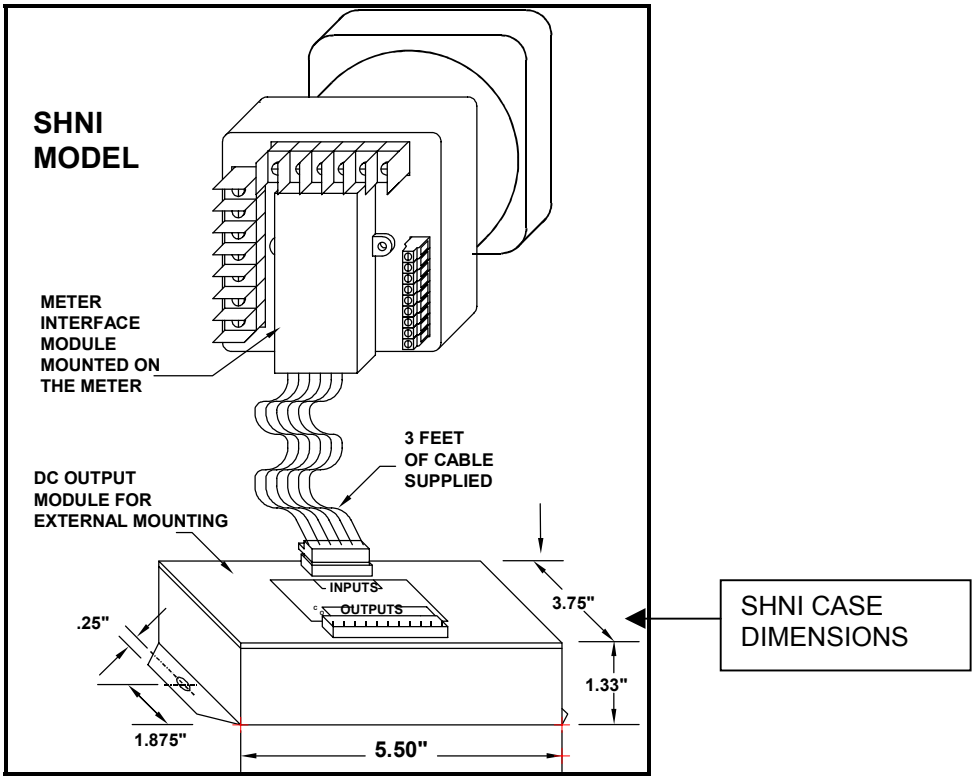


Figure 1.3: Model SHNI External Mounting Installation



CHAPTER 2
ELECTRICAL INSTALLATION

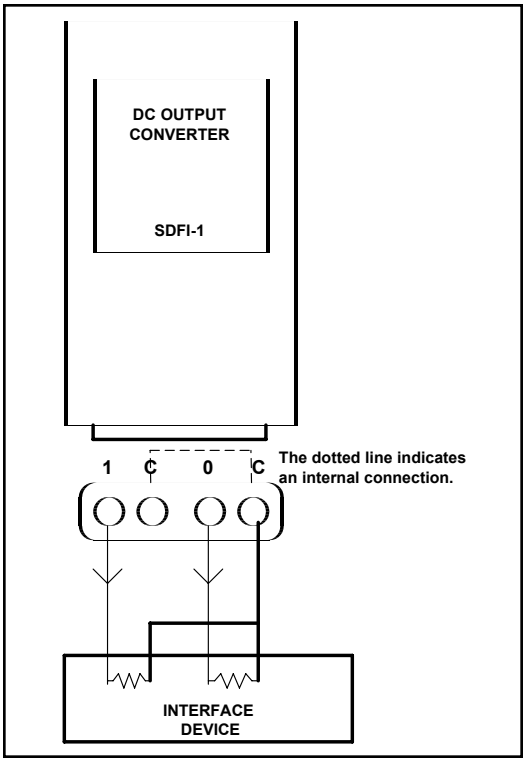


Figure 2.1:

SDFI-1 Electrical Installation

2-Channel 0-1 mA DC Analog Output Converter

NOTE: DO NOT exceed 10k Ohms input impedance.

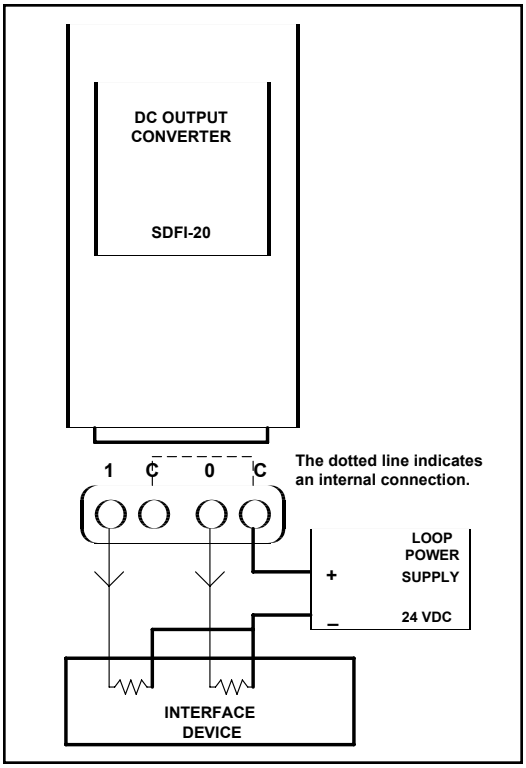


Figure 2.2:

SDFI-20 Electrical Installation

2-Channel 4-20 mA DC Analog Output Converter

NOTE: DO NOT exceed 40VDC on Loop Power Supply. (24VDC Recommended.) DO NOT exceed 250 Ohms impedance.

Table 2.1: Electrical Connections for SDFI

PIN OUT (From Left)	INTERFACE CONNECTIONS (From Left)
1	Output #1
C	Common
0	Output #0
C	Common

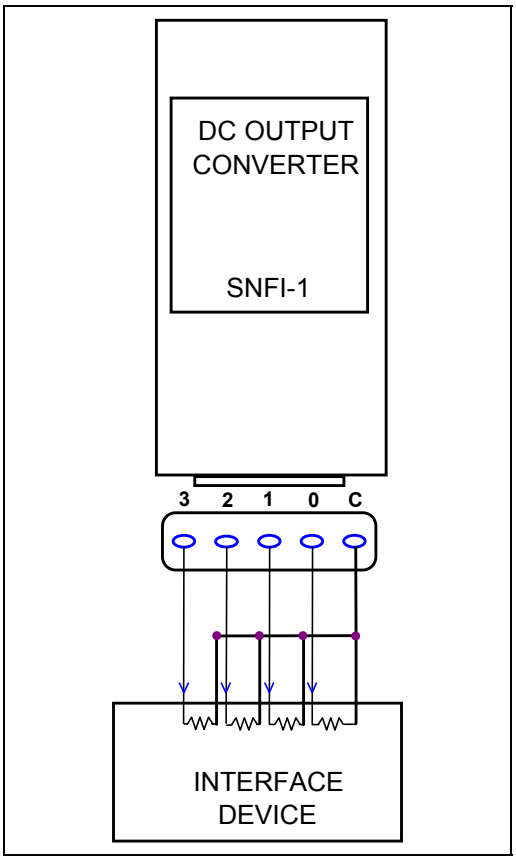


Figure 2.3:

SNFI-1 Electrical Installation

4-Channel 0 - 1 mA DC Analog Output Converter

NOTE: DO NOT exceed 10k Ω input impedance.

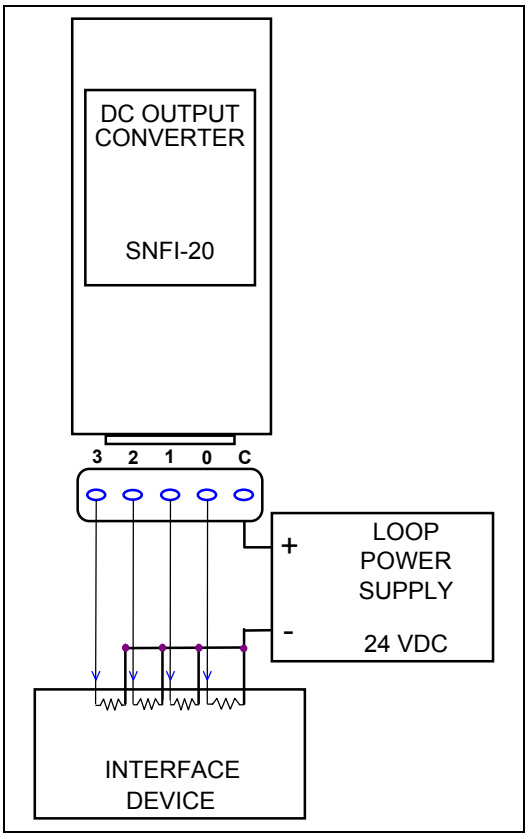


Figure 2.4:

SNFI-20 Electrical Installation

4-Channel 4 - 20 mA DC Analog Output Converter

NOTE: DO NOT exceed 40VDC on Loop Power Supply. (24VD Recommended) DO NOT exceed 250 Ω impedance.

Table 2.2: Electrical Connections for SNFI

PIN OUT (From Left)	INTERFACE CONNECTIONS (From Left)
3	Output #3
2	Output #2
1	Output #1
0	Output #0
C	Common

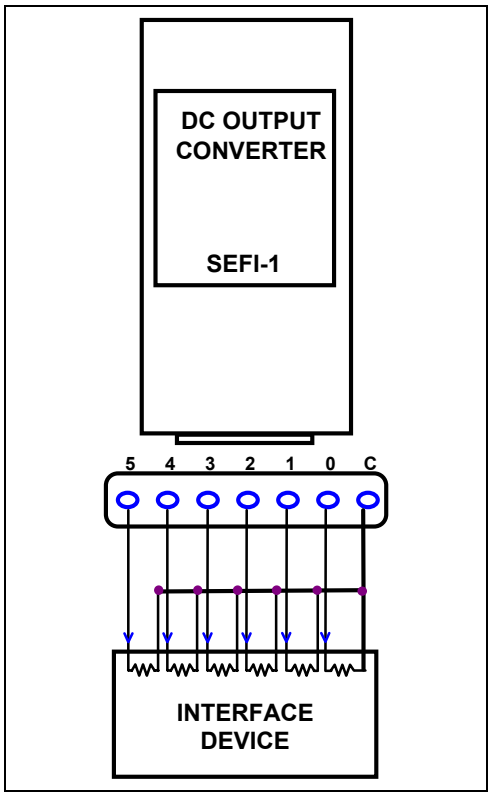


Figure 2.5:

SEFI-1 Electrical Installation

6-Channel 0 - 1 mA DC Analog Output Converter

NOTE: DO NOT exceed 10k Ω Input Impedance.

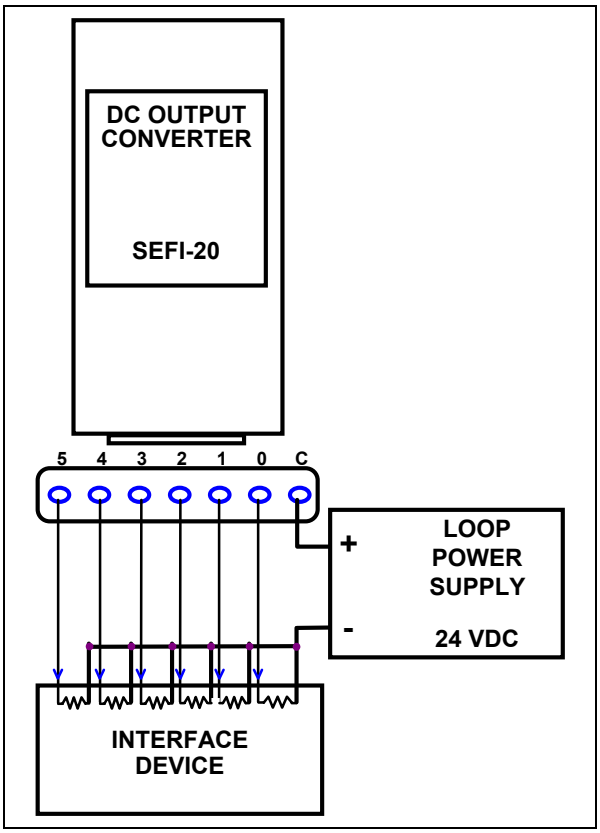


Figure 2.6:

SEFI-20 Electrical Installation

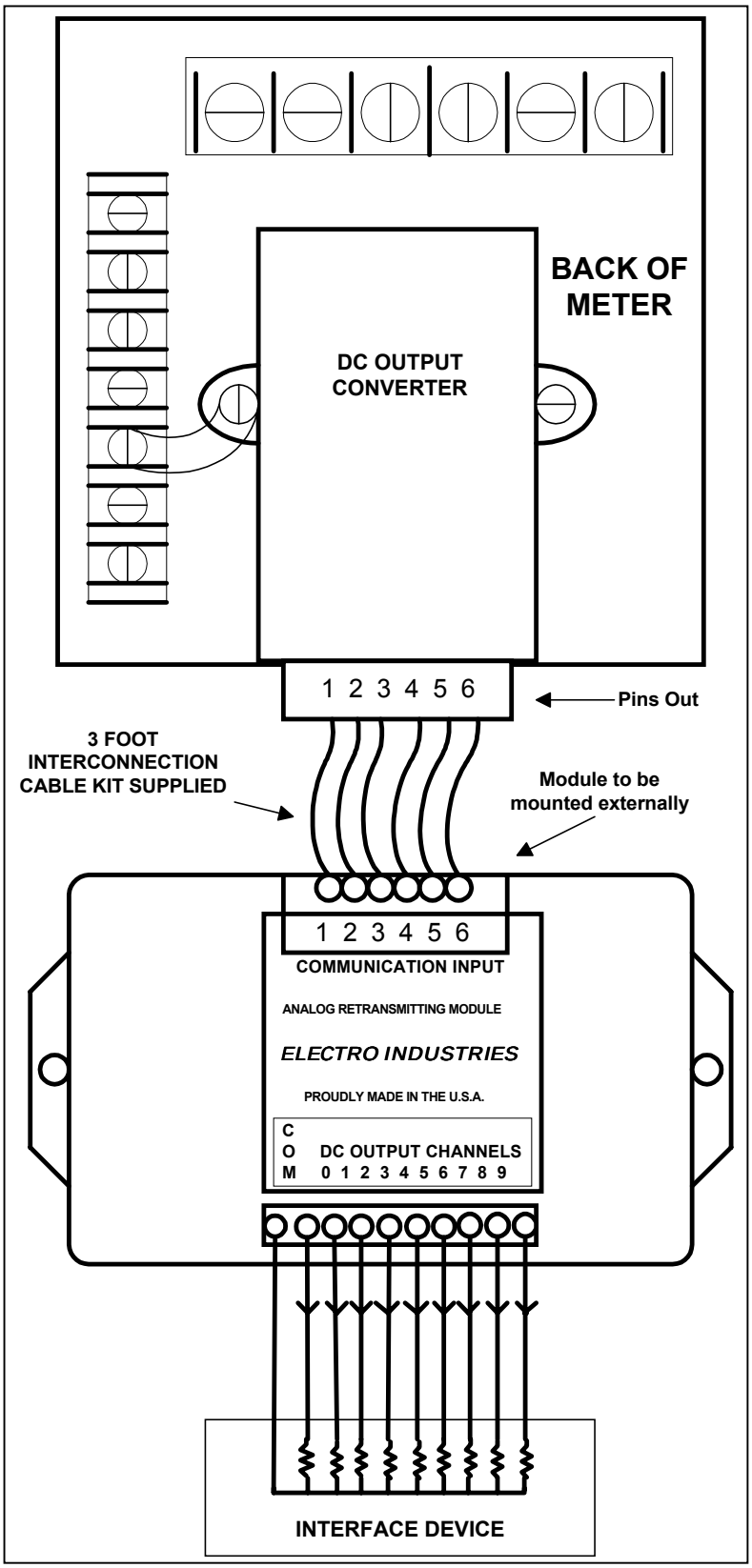
6-Channel 4 -20mA DC Analog Output Converter

NOTE: DO NOT exceed 40VDC on Loop Power Supply.
(24VDC Recommended)
DO NOT exceed 250 Ω impedance.

Table 2.3: Electrical Connections for SEFI

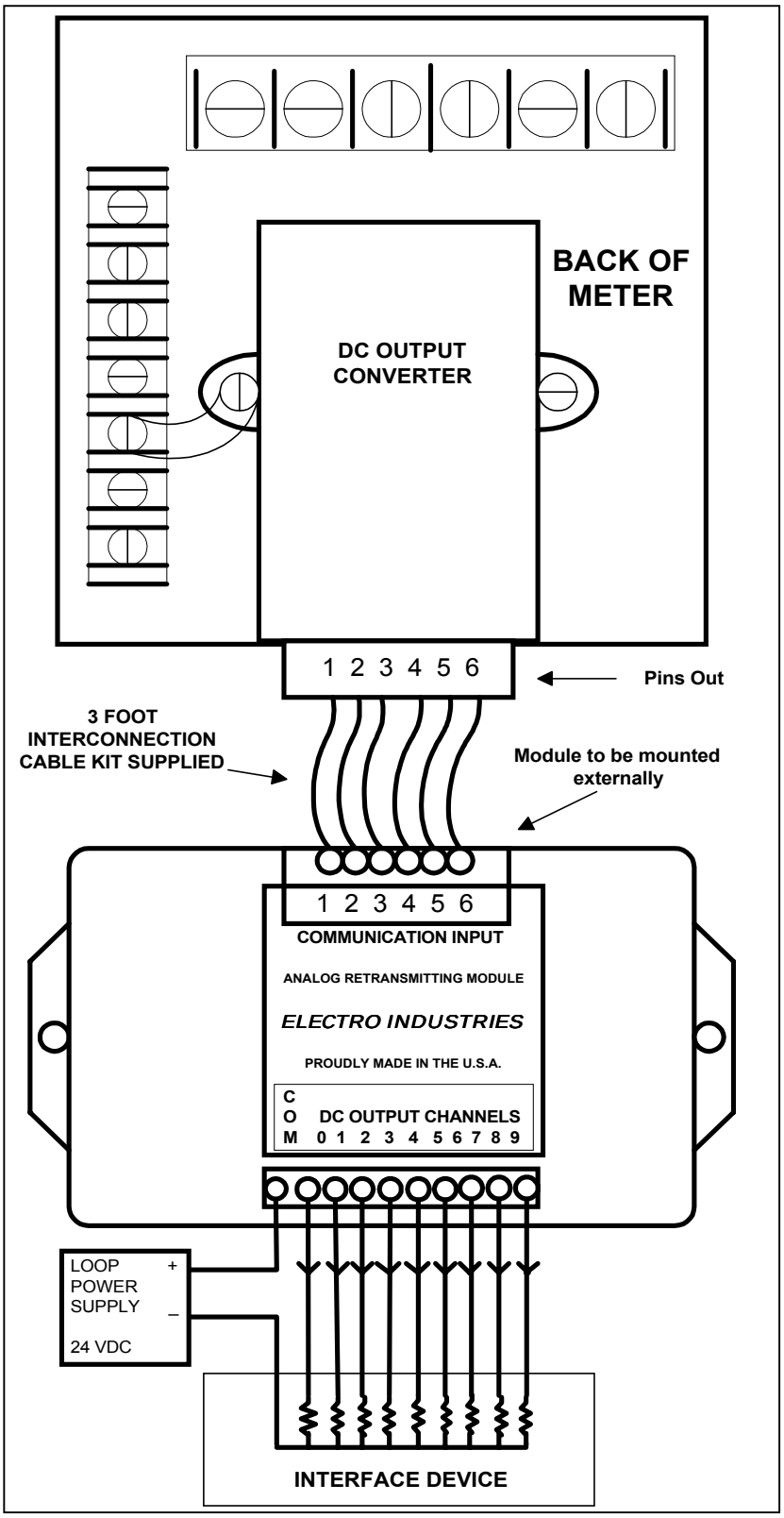
PIN OUT (From Left)	INTERFACE CONNECTIONS (From Left)
5	Output #5
4	Output #4
3	Output #3
2	Output #2
1	Output #1
0	Output #0
C	Common

Figure 2.7: SHNI-1 Electrical Installation 10-Channel 0 - 1 mA DC Analog Output Converter



NOTE: DO NOT exceed 10k Ω Input Impedance.

Figure 2.8: SHNI-20 Electrical Installation 10-Channel 4 - 20 mA DC Analog Output Converter



NOTE: DO NOT exceed 40VDC on Loop Power Supply. (24VDC Recommended)
DO NOT exceed 250 Ω impedance.

CHAPTER 3
DC ANALOG OUTPUT MODULE OVERVIEW

3.1: Electro Industries DC Analog Output Modules

Electro Industries' family of DC Analog Output Modules allows **2 to 10 channels of transducer outputs** to interface with many of our DM Series monitors. The channels are unidirectional and/or bi-directional and **can be mapped to any scaling or reading**. The user can select the scaling, including positive and negative full scale and zero scaling. The output signals can be mapped to various readings, such as Wattage, VARS, VA, PF, Frequency, Volts (L-L or L-N) or Amps A, B, C and N.

The DC Analog Output Modules use a 12-bit digital to analog converter coupled with precision components to provide output with the same accuracy as rated for the meter display.

DC Analog Output Modules Features:

- 2-Channel, 4-Channel, 6-Channel and 10-Channel units are available.
- Unidirectional or Bi-directional Outputs.
  - 0-1mA: Unidirectional reads from 0-1mA.
    Bi-directional reads from (-1mA) -(0) -(+1mA).
  - 4-20mA: Unidirectional reads from 4-20mA.
    Bi-directional reads from (4mA) -(12mA) -(20mA).
- Preset to factory defaults based upon typical use.
- Completely programmable modules.
- Effective resolution: 12 bit D/A (Digital to Analog).
- Output range: 0 - 1 mA, 4 - 20 mA.
- Output type: DC.
- Isolation Voltage: 1500VDC.
- All modules contain at least one common (ground point).
- The outputs can be mapped to various readings, such as:
  - Wattage (A, B, C and Total)
  - VARS (A, B, C and Total)
  - VA, PF, Frequency
  - Volts (L-L or L-N)
  - Amps (A, B, C and N)

3.2: 2-Channel SDFI-1 (0-1mA) and SDFI-20 (4-20mA) DC Output Modules

The **SDFI-1** and the **SDFI-20** 2-Channel Modules are typically used with EIG DMWH and 3DWA meters, or where only 2 channels are required. Typical parameters are Total Watts, Watts Demand and Total VARS. Both modules have unidirectional or bi-directional outputs that can be programmed for any scaling. They are usually preset at the factory for bi-directional output.

The tables below show the meter models typically used with the **SDFI**, based on the number of readings performed by the meter. The tables display the factory default DC Output Channel Mappings (parameter assignments to the DC Output Channels). The mapping for each meter model is programmed according to the appropriate table, unless otherwise specified.

Table 3.1: DC Output Modules 2-Channel 0-1mA and SDFI-20 2-Channel 4-20mA factory defaults for meter models DMWH300 and 3DWA300:

Channel	Channel Capabilities		Factory Defaults					
			DMWH300			3DWA300		
			0-1mA	4-20mA	Parameter	0-1mA	4-20mA	Parameter
0	BI	UNI	**BI**	**UNI**	WATTS	**BI**	**UNI**	WATTS
1	BI	UNI	**BI**	**BI**	WATTS DEMAND	**BI**	**BI**	VARS

NOTE:

BI = Bi-directional Output
UNI = Unidirectional Output

3.3: 4-Channel SNFI-1 (0-1mA) and SNFI-20 (4-20mA) DC Output Modules

The **SNFI-1** and the **SNFI-20** 4-Channel Modules are typically used with EIG 3DAA5 ammeters and 3DVA120 voltmeters, or where only 4 channels are required. The usual parameters for the four channels are Amps and Volts. The **SNFI-1** has only unidirectional outputs. The **SNFI-20** can be set for unidirectional or bi-directional outputs that can be programmed for any scaling. The usual settings for the **SNFI-20** are unidirectional.

The tables below show the meter models typically used with the **SNFI**, based on the number of readings performed by the meter. The tables display the factory default DC Output Channel Mappings (parameter assignments to the DC Output Channels). The mapping for each meter model is programmed according to the appropriate table, unless otherwise specified.

Table 3.2: DC Output Modules SNFI-1 and SNFI-20 4-Channel factory defaults for 3DAA5 meters:

0-1mA with 3DAA5				4-20mA with 3DAA5				
Channel	**Channel Capabilities**		**Parameter Defaults**	**Channel**	**Channel Capabilities**		**Channel Defaults**	**Parameter Defaults**
0		**UNI**	AMPS A	0	BI	UNI	**UNI**	AMPS A
1		**UNI**	AMPS B	1	BI	UNI	**UNI**	AMPS B
2		**UNI**	AMPS C	2	BI	UNI	**UNI**	AMPS C
3		**UNI**	AMPS N	3	BI	UNI	**UNI**	AMPS N

Table 3.3: DC Output Modules SNFI-1 and SNFI-20 4-Channel factory defaults for 3DVA120 meters:

0-1mA with 3DVA120				4-20mA with 3DVA120				
Channel	**Channel Capabilities**		**Parameter Defaults**	**Channel**	**Channel Capabilities**		**Channel Defaults**	**Parameter Defaults**
0		**UNI**	VOLTS A-N	0	BI	UNI	**UNI**	VOLTS A-N
1		**UNI**	VOLTS B-N	1	BI	UNI	**UNI**	VOLTS B-N
2		**UNI**	VOLTS C-N	2	BI	UNI	**UNI**	VOLTS C-N
3		**UNI**	VOLTS A-B	3	BI	UNI	**UNI**	VOLTS A-B

Table 3.4: DC Output Modules SNFI-1 and SNFI-20 4-Channel factory defaults for 3DVA120 Delta Programmed meters:

0-1mA with 3DVA120-Delta Programmed				4-20mA with 3DVA120-Delta Programmed				
Channel	**Channel Capabilities**		**Parameter Defaults**	**Channel**	**Channel Capabilities**		**Channel Defaults**	**Parameter Defaults**
0		**UNI**	VOLTS A-B	0	BI	UNI	**UNI**	VOLTS A-B
1		**UNI**	VOLTS B-C	1	BI	UNI	**UNI**	VOLTS B-C
2		**UNI**	VOLTS C-A	2	BI	UNI	**UNI**	VOLTS C-A
3		**UNI**		3	BI	UNI	**UNI**	

NOTE: BI = Bi-directional Output UNI = Unidirectional Output

3.4: 6-CHANNEL SEFI-1 (0-1 mA) / SEFI-20 (4-20 mA) DC OUTPUT MODULES

The **SEFI-1** (0-1mA) and **SEFI-20** (4-20mA) are 6-Channel DC Output Modules that are typically used with the EIG DWVA300 meter, or where 6 channels are required. Usual parameters are Amps, Watts, and VARS. On the SEFI-1, two of the channels (0 and 1) can produce either a bi-directional or unidirectional DC Output. Channels 2-5 are for unidirectional output operation only. On the SEFI-20, all channels are bi-directional and defaults are unidirectional, except for Channel 1.

The tables below show the meter model (DWVA300) typically used with the **SEFI**, based on the number of readings performed by the meter. The tables display the factory default DC Output Channel Mappings (parameter assignments to the DC Output Channels). The mapping for each meter model is programmed according to the appropriate table, unless otherwise specified.

Table 3.5: SEFI-1 (0-1 mA 6-Channel DC Output) and factory defaults for DWVA300 Watt/VAR/Amp meters:

DWVA300				
Channel	**Channel Capabilities**		**Channel Defaults**	**Parameter Defaults**
0	BI	UNI	**BI**	TOTAL WATTS
1	BI	UNI	**BI**	TOTAL VARS
2		UNI	**UNI**	AMPS A
3		UNI	**UNI**	AMPS B
4		UNI	**UNI**	AMPS C
5		UNI	**UNI**	AMPS N

Table 3.6: SEFI-20 (4-20 mA 6-Channel DC Output) and factory defaults for DWVA300 Watt/VAR/Amp meters:

DWVA300				
Channel	**Channel Capabilities**		**Channel Defaults**	**Parameter Defaults**
0	BI	UNI	**UNI**	TOTAL WATTS
1	BI	UNI	**UNI**	TOTAL VARS
2	BI	UNI	**UNI**	AMPS A
3	BI	UNI	**UNI**	AMPS B
4	BI	UNI	**UNI**	AMPS C
5	BI	UNI	**UNI**	AMPS N

NOTE:

BI = Bi-directional Output
UNI = Unidirectional Output

3.5: 10-CHANNEL SHNI-1 (0-1 mA Model) / SHNI-20 (4-20 mA Model)

The **SHNI-1** and **SHNI-20** are 10-Channel DC Output Modules that are designed to work with many EIG monitors, including the DMMS300+, DMMS300+ Delta and DWVA300 models. Usual parameters are Volts, Amps, Watts, VARS, Frequency and Power Factor. The 10-channel 0-1mA module consists of 6 channels, which can be unidirectional or bi-directional, and 4 channels, which are unidirectional only. The 4-20mA module consists of 10 channels, all of which can be programmed for unidirectional or bi-directional output.

The tables below show the meter models typically used with the **SHNI-1** and **SHNI-20**, based on the number of readings performed by the meter. The tables display the factory default DC Output Channel Mappings (parameter assignments to the DC Output Channels). The mapping for each meter model is programmed according to the appropriate table, unless otherwise specified.

Table 3.7: SHNI-1 (0-1 mA 10-Channel DC Output) defaults for DMMS300+, DMMS300+ Delta programmed meters:

Channels	Channel Capabilities		Channel Defaults	DMMS300+ Parameter Defaults	DMMS300+ DELTA Parameter Defaults
0	BI	UNI	**BI**	Total Watts	Total Watts
1	BI	UNI	**BI**	Total VARS	Total VARS
2	BI	UNI	**BI**	Frequency	Frequency
3	BI	UNI	**UNI**	Volts A-N	Volts A-B
4	BI	UNI	**UNI**	Volts B-N	Volts B-C
5	BI	UNI	**UNI**	Volts C-N	Volts C-A
6		UNI	**UNI**	Amps A	Amps A
7		UNI	**UNI**	Amps B	Amps B
8		UNI	**UNI**	Amps C	Amps C
9		UNI	**UNI**	Amps N	

Table 3.8: SHNI-20 (4-20 mA 10-Channel DC Output) defaults for DMMS300+, DMMS300+ Delta programmed meters:

Channels	Channel Capabilities		Channel Defaults	DMMS300+ Parameter Defaults	DMMS300+ DELTA Parameter Defaults
0	BI	UNI	**UNI**	Total Watts	Total Watts
1	BI	UNI	**UNI**	Total VARS	Total VARS
2	BI	UNI	**UNI**	Frequency	Frequency
3	BI	UNI	**UNI**	Volts A-N	Volts A-B
4	BI	UNI	**UNI**	Volts B-N	Volts B-C
5	BI	UNI	**UNI**	Volts C-N	Volts C-A
6	BI	UNI	**UNI**	Amps A	Amps A
7	BI	UNI	**UNI**	Amps B	Amps B
8	BI	UNI	**UNI**	Amps C	Amps C
9	BI	UNI	**UNI**	Amps N	

NOTE: BI = Bi-directional Output UNI = Unidirectional Output

Table 3.9: SHNI-1 (0-1 mA 10-Channel DC Output) factory defaults for the DWVA300 are:

Channels	Channel Capabilities		Channel Defaults	DWVA300 Parameters
0	BI	UNI	**BI**	Watts A
1	BI	UNI	**BI**	Watts B
2	BI	UNI	**BI**	Watts C
3	BI	UNI	**BI**	VARS A
4	BI	UNI	**BI**	VARS B
5	BI	UNI	**BI**	VARS C
6		UNI	**UNI**	Amps A
7		UNI	**UNI**	Amps B
8		UNI	**UNI**	Amps C
9		UNI	**UNI**	Amps N

Table 3.10: SHNI-20 (4-20 mA 10-Channel DC Output) factory defaults for the DWVA300 are:

Channels	Channel Capabilities		Channel Defaults	DWVA300 Parameters
0	BI	UNI	**UNI**	Watts A
1	BI	UNI	**UNI**	Watts B
2	BI	UNI	**UNI**	Watts C
3	BI	UNI	**UNI**	VARS A
4	BI	UNI	**UNI**	VARS B
5	BI	UNI	**UNI**	VARS C
6	BI	UNI	**UNI**	Amps A
7	BI	UNI	**UNI**	Amps B
8	BI	UNI	**UNI**	Amps C
9	BI	UNI	**UNI**	Amps N

NOTE:

BI = Bi-directional
UNI = Unidirectional

3.6: DC Output Chart

Tables 3.11 and 3.12 are provided to give you an idea what range of readings to expect from your DC Output Module. Nominal inputs are used in the factory during calibration. Those values are determined by the specific version of the meter you have. Meter versions can be determined by examining the label of the meter.

NOTE: Nominal values for Volts and Current used in the design and calibration of meters.

The tables illustrate how the different meter models (having different input specifications) are calibrated at the factory (Voltage and Current) based on the model (Measurement). Using those values, the meter can monitor and output the range of readings (Meter Input) when equipped with the appropriate (programmed and calibrated) DC Output Module. Meter Output/Reading Ranges for 0-1 mA and 4-20 mA output modules are shown. The Meter Ranges in the chart apply to all output modules, unless otherwise noted. All readings are in secondary, not the displayed reading.

Table 3.11: Output Ranges for 0-1 mA DC Analog Output Modules

Measurement	Nominal Inputs		Unidirectional 0-1 mA Output (Secondary)	Bi-directional -1 - 0 - +1 mA Output (Secondary)*
	Voltage	Current		
Voltage - Suffix L	75V	_	0 - +75V	Not Recommended
Voltage - No Suffix	150V	_	0 - +150V	Not Recommended
Voltage - Suffix G	300V	_	0 - +300V	Not Recommended
Current	_	5A	0 - +5A	Not Recommended
3 Element Watt/VAR - WYE Suffix L	50V	5A	0 - +750W	-750 - 0 - +750W
3 Element Watt/VAR - WYE No Suffix	100V	5A	0 - +1500W	-1500 - 0 - +1500W
3 Element Watt/VAR - WYE Suffix G	200V	5A	0 - +3000W	-3000 - 0 - +3000W
2 Element Open Delta Watt/VAR Suffix L	50V	5A	0 - +500W	-500 - 0 - +500W
2 Element Open Delta Watt/VAR No Suffix	100V	5A	0 - +1000W	-1000 - 0 - +1000W
2 Element Open Delta Watt/VAR Suffix G	200V	5A	0 - +1500W	-1500 - 0 - +1500W
Power Factor	_	_	Not Recommended	-0.500 -1- +0.500PF
Frequency - 50 Hz	_	_	Not Recommended	45 - 50 - 55 Hz
Frequency - 60 Hz	_	_	Not Recommended	55 - 60 - 65 Hz

***NOTE: SNFI-1 (4-Channel 0-1mA Output) is unidirectional ONLY and should not be used in Bi-directional Mode on any output.**

Factory Calibration and Setting Equivalents:

Nominal Secondary Watts = (Vn) x (In) x (elements)
= 100V x 5A x 3
= 1500W

NOTE: DELTA = 2 elements
WYE = 3 elements

Table 3.12: Output Ranges for 4-20 mA DC Analog Output Modules

Measurement	Nominal Inputs		Unidirectional 4 - 20 mA Output (Secondary)	Bi-directional 4 - 12 - 20 mA Output (Secondary)
	Voltage	Current		
Voltage - Suffix L	75V	_	0 - +75V	Not Recommended
Voltage - No Suffix	150V	_	0 - +150V	Not Recommended
Voltage - Suffix G	300V	_	0 - +300V	Not Recommended
Current	_	5A	0 - +5A	Not Recommended
3 Element Watt/VAR - WYE Suffix L	50V	5A	0 - +750W	-750 - 0 - +750W
3 Element Watt/VAR - WYE No Suffix	100V	5A	0 - +1500W	-1500 - 0 - +1500W
3 Element Watt/VAR - WYE Suffix G	200V	5A	0 - +3000W	-3000 - 0 - +3000W
2 Element Open Delta Watt/VAR Suffix L	50V	5A	0 - +500W	-500 - 0 - +500W
2 Element Open Delta Watt/VAR No Suffix	100V	5A	0 - +1000W	-1000 -0- +1000W
2 Element Open Delta Watt/VAR Suffix G	200V	5A	0 - +1500W	-1500 -0- +1500W
Power Factor	_	_	Not Recommended	-0.500 -1- +0.500 PF
Frequency - 50 Hz	_	_	Not Recommended	45 - 50 - 55 Hz
Frequency - 60 Hz	_	_	Not Recommended	55 - 60 - 65 Hz

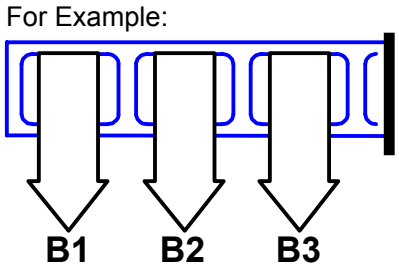
CHAPTER 4
DC OUTPUT MODULE PROGRAMMING

Note: If the DC Output Module was purchased with a meter, all programming was performed at the factory. If purchased separately, follow programming procedure below. Please see **Appendices B and C,** which will serve as a guide in the setup of the DC Output Module.

4.1: Keypad Buttons

The keypad buttons used for programming are **B1, B2, and B3.** Button position one or **B1** will always begin from the left. Actual labeling for the keypads varies by model and function varies with mode. Simply follow the steps and illustrations in this chapter and following chapters to accomplish programming, mapping and caliabration.

Figure 4.1: Keypad Buttons



4.2: Outline of the Programming Procedure

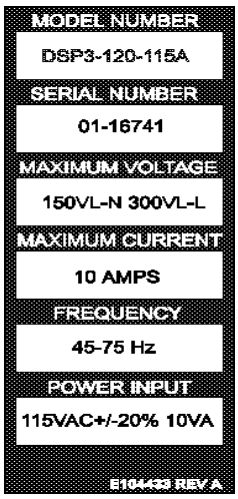
Part I

Enter the Programming Mode for the particular module (see section 4.3 of this manual for most models). For Programming of the Meter Model DMWH300, see Chapter 8 of this manual.

Part II

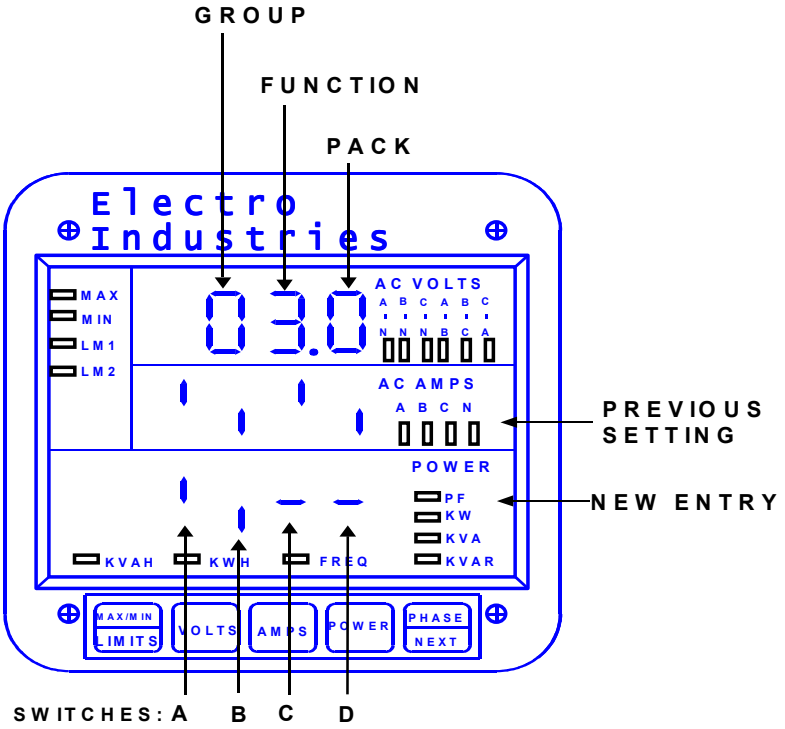
Select the desired GROUP: Programming Group 8, Pack 0 (8P.0).
Find Model Number, Voltage Range and Frequency on the Meter Label. See Figure 4.2 below.
See section **4.3** to input data.

Figure 4.2: Example Label



FUNCTIONS are subcategories of Groups. Some Functions are further divided into **PACKS**, which contain four **SWITCHES** referred to as **SWITCHES A, B, C, D** from left to right. See Figure 4.3 below.

Figure 4.3: Groups, Functions, Packs and Switches



Part III

Switch packs 8P.1, 8P.2, and 8P.3

Select unidirectional or bi-directional operation for up to ten output channels. See description of models in Chapter 3.

NOTE: Bi-directional output is not available for all models and channels.

PART IV

Channels 0 through 9.

Programming locations for channels 0 through 9. Once a channel is selected, the parameter assignment can be changed (see Chapter 5). Repeat parameter assignment for each channel.

PART V

Exit the Operating Mode to store the new programming.

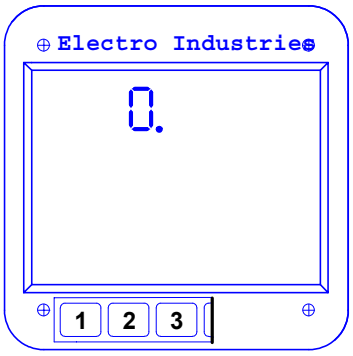
NOTE: Calibration should not be required for any units shipped with a meter and for 6- and 10-Channel DC Analog Outputs. These modules ship with an EEprom storing the calibration values. The 2- and 4-Channel DC Outputs do not have the EEprom and need to be field calibrated.

4.3: Entering the Programming Mode

Entering the Programming Mode varies, depending on the meter model. See the User Manual for your particular meter model.

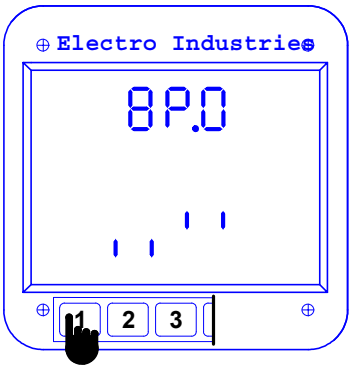
Note: Press B1 at any time to **CANCEL** before storing the last digit or switch.

The following steps apply to ALL models except DMWH (see Chapter 8 of this manual for DMWH):



STEP 1:
a. Refer to the Programming Manual of the instrument being programmed. Enter Programming Mode. The above screen should appear.

NOTE: If **8.E** appears on the screen during the following steps, the meter is not set up for DC Output. Refer to the Programming Manual of the instrument being programmed.

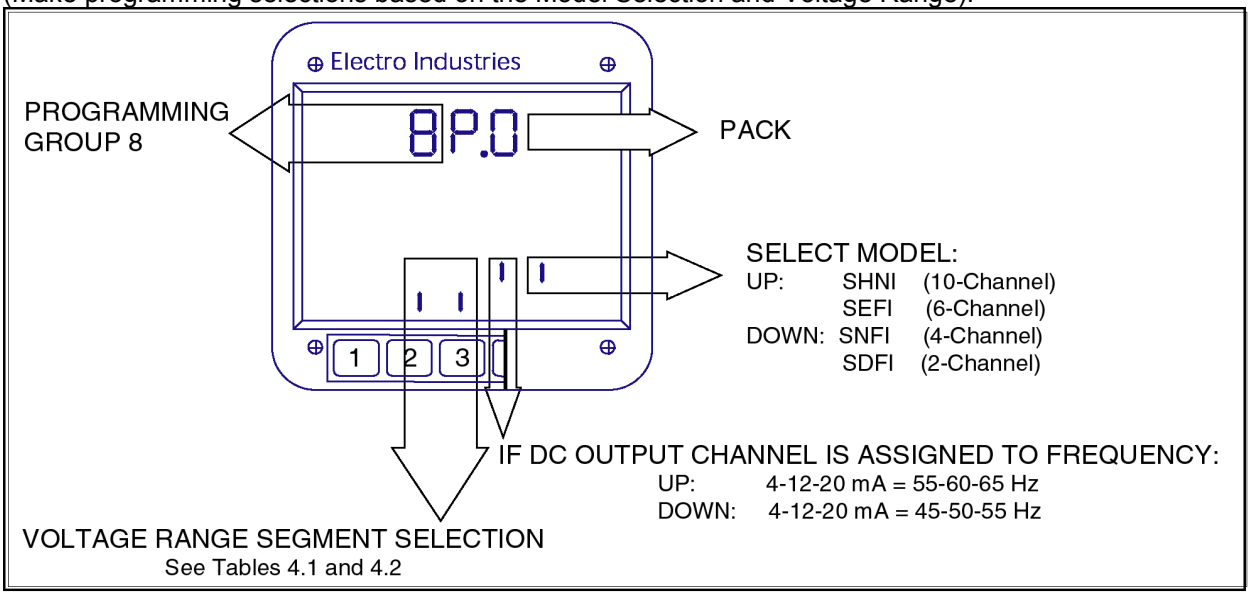


STEP 2:
a. Press Keypad **B1** until Group 8 is reached.

b. Press **B3** to enter DC Output Programming Group.

c. See **Figure 4.3** below to define segments of the display and to determine whether switches should be **UP** or **DOWN**.

Figure 4.4: Model and Range Selection
(Make programming selections based on the Model Selection and Voltage Range).



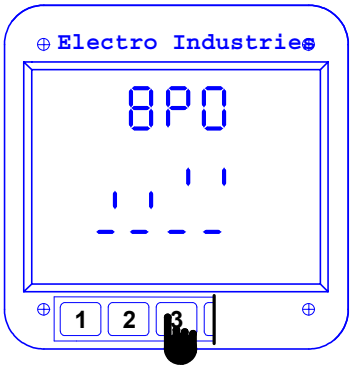
NOTE: Programming of Model and Range Selection is set at the factory.

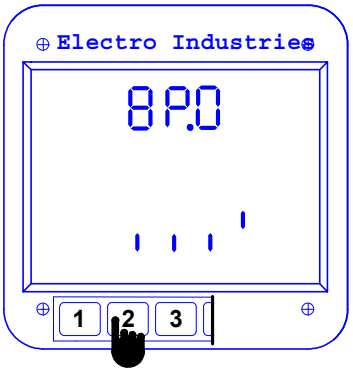
Table 4.1: Available Packs

PACK	DESCRIPTION
0	Model and Voltage Range Selection and Frequency Selection
1	Mapping and Calibration Channels 0-3
2	Mapping and Calibration Channels 4-7
3	Mapping and Calibration Channels 8-9

Table 4.2: Voltage Range Segment Positions

VOLTAGE RANGE	DSP TERMINAL MODULE	VOLTAGE RANGE SEGMENT POSITION
75 VAC L-N	Suffix L DSP-L	
150 VAC L-N	No Suffix (Standard) DSP	
300 VAC L-N	Suffix G DSP-G	





STEP 3:

Data Entry Sequence (for PACKS)

a. Press **B3** to begin data entry sequence.

⇨Refer to Figure 4.4 for selections.

STEP 4:

a. Press **B2** to toggle segments UP or DOWN for desired setting.

b. Press B1 to Cancel.

c. Press **B3** to store.

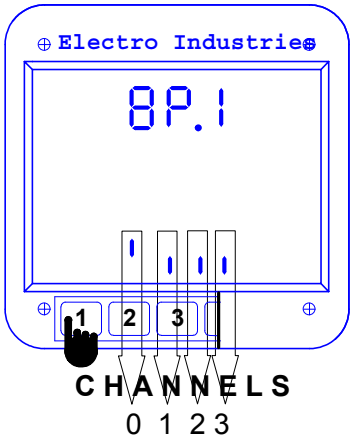
See Chapter 6 to Exit, or continue.

4.4: Setting the Channels

In this section, you are setting the channels to be either **unidirectional** or **bi-directional.**
As shown below, the number of packs will vary according to the number of channels you have in your module.

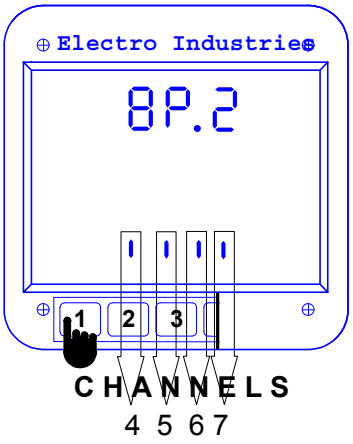
SEGMENT UP = Unidirectional
SEGMENT DOWN = Bi-directional

PACK NO. 1



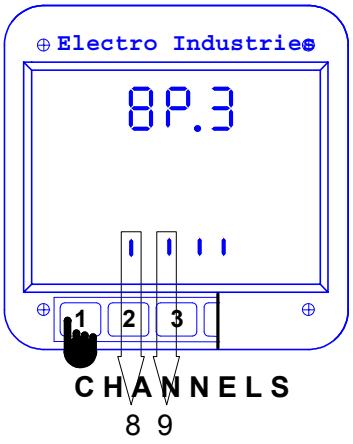
Available for All Channel Models.

PACK NO. 2



Available for 6- and 10-Channel Models.

PACK NO. 3

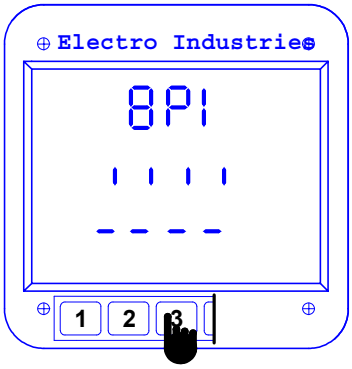


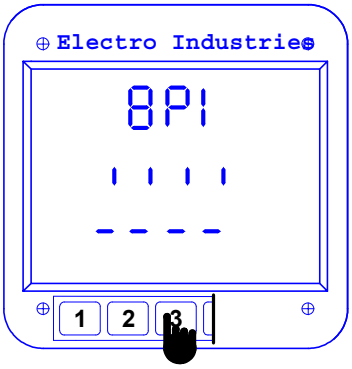
Available for the 10-Channel Model.

STEP 5:

a. Press **B2** to continue.

NOTE: Remember - SEGMENT UP = Unidirectional; SEGMENT DOWN = Bi-directional





NOTE: For a 2-Channel Module, you will set ONLY the first 2 switch segments.

For 4-, 6- or 10-Channel Modules you will set ALL of these switch segments.

STEP 6:

a. Press **B3** to begin data entry sequence.

STEP 7:

a. Press **B2** to toggle segments UP or DOWN for desired setting.

b. Press B1 to Cancel.

b. Press **B3** to store.

See Chapter 6 to Exit.

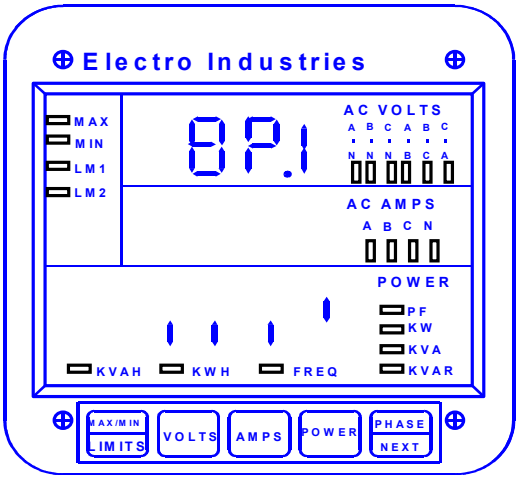
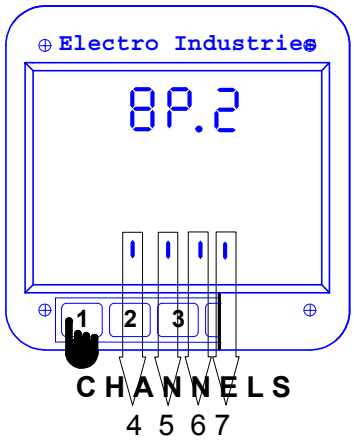


Figure 4.5: Detail of Segment Selections on the Display

PACK NO. 2



Available for 6- and 10-Channel Models.

NOTE: For a 6-Channel Module, you will set ONLY the first 2 switches. For a 10-Channel Module, you will set ALL of the switches.

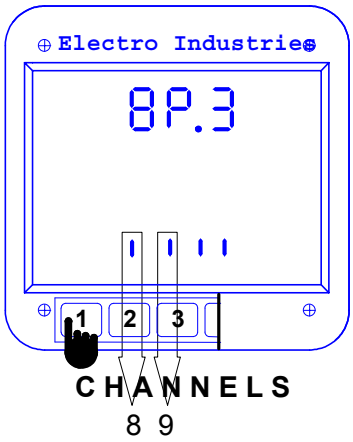
STEP 8:

a. Press B2 to continue.

NOTE: Remember -
SEGMENT UP = Unidirectional
SEGMENT DOWN = Bi-directional

b. Repeat Steps 6 and 7 for PACK NUMBER 2.

PACK NO. 3



Available for the 10-Channel Model.

NOTE: For a 10-Channel Module, you will set ONLY the first 2 switches.

STEP 9:

a. Press B2 to continue.

NOTE: Remember -
SEGMENT UP = Unidirectional
SEGMENT DOWN = Bi-directional

b. Repeat Steps 6 and 7 for PACK NUMBER 3.

NOTE: See Chapter 3 for the FACTORY DEFAULT SETTINGS for all of the channels of the various modules.

CHAPTER 5
CHANNEL MAPPING

5.1: Channel Mapping

Channel Mapping: assigns a parameter to a channel.

EXAMPLE:

Using the Keypad Buttons below (see Figure 5.1), VOLTS AN could be mapped to Channel 0 by selecting parameter 0 in the middle display (see Channel Mapping **Step 4.c** below).

Figure 5.1: Keypad Buttons

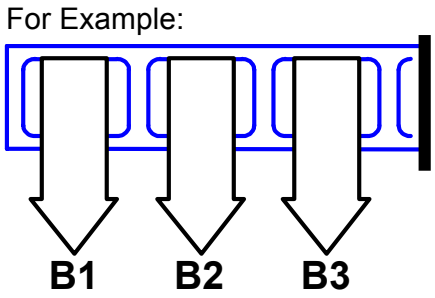


Table 5.1: Standard Parameters for Channel Mapping

Parameter	Parameter Number
Volts AN	0
Volts BN	1
Volts CN	2
Volts AB (Not available for Wye connection unless specially calibrated)	3
Volts BC (Not available for Wye connection unless specially calibrated)	4
Volts CA (Not available for Wye connection unless specially calibrated)	5
Amps A	6
Amps B	7
Amps C	8
Amps N	9
Total Watts	10
Total VARS	11
Total VA	12
Power Factor (Bi-directional DC Output must be selected in 8P1)	13
Frequency (Bi-directional DC Output must be selected in 8P1)	14

NOTE: See **Appendix A** for a complete list of standard and extended parameters and availability by model.

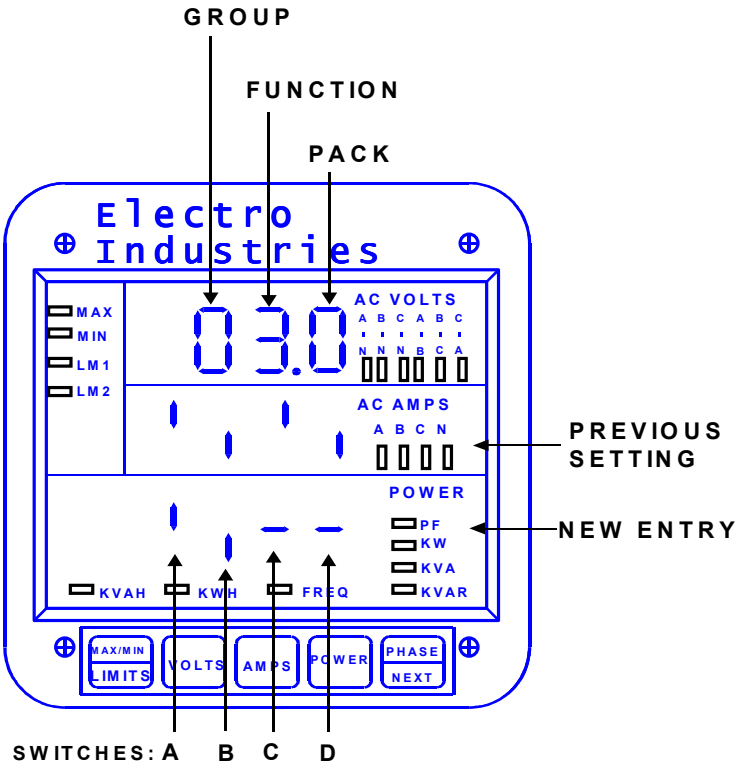
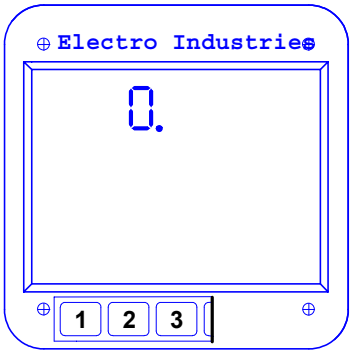


Figure 5.2: Detail of Programming Components

5.2: Entering the Programming Mode

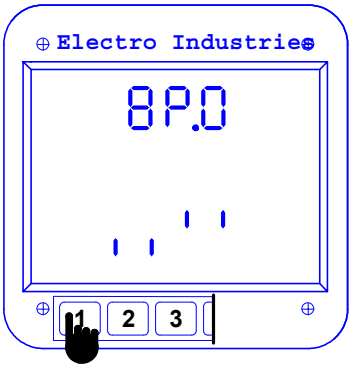
Entering the Programming Mode varies, depending on the meter model. See the User Manual for your particular meter model.
Note: Press B1 at any time to **CANCEL** before storing the last digit or switch.

The following steps apply to ALL models except DMWH (see Chapter 8 of this manual for DMWH):



STEP 1:
a. Refer to the Programming Manual of the instrument being programmed. Enter Programming Mode. The above screen should appear.

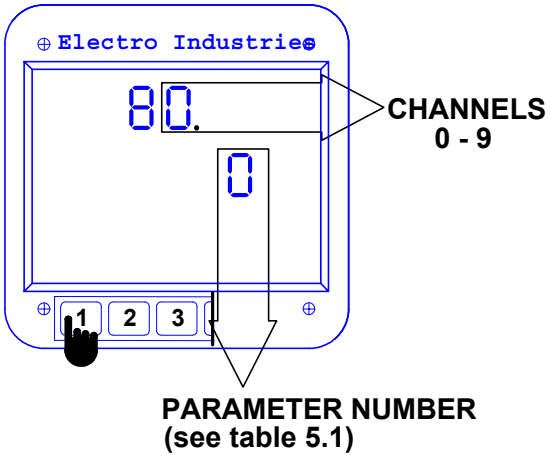
NOTE: If **8.E** appears on the screen during these steps, the meter is not set up for DC Output. Refer to the Programming Manual of the instrument being programmed.



STEP 2:
a. Press Keypad **B1** until Group 8 is reached.

b. Press **B3** to enter DC Output Programming Group.

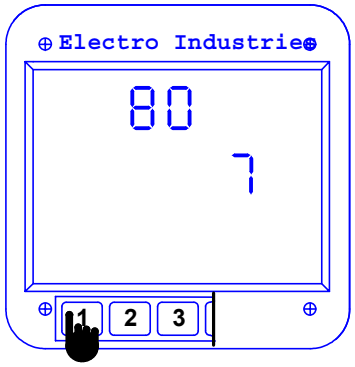
5.3: Mapping the Channels



STEP 3:
a. Press **B1** to select a channel.

NOTE: Select Channels 0 - 9. The second digit corresponds to the channel being mapped.

b. Press **B3** to begin Data Entry Sequence. The decimal point disappears from the channel number.



STEP 4:
a. Press **B1** to move to next parameter.

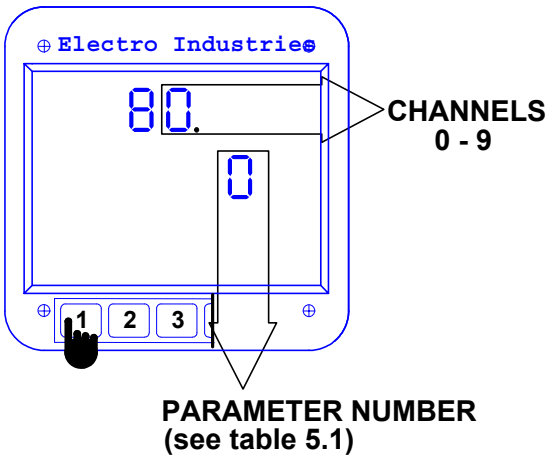
b. Press **B2** to move to previous parameter.

c. Press **B3** to **store Parameter to the selected Channel.**

⇨Refer to Table 5.1 for list of Parameters.

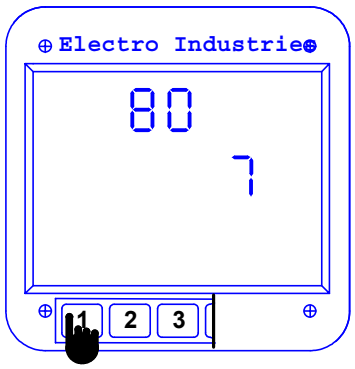
⇨After pressing **B3**, the **MAX** and **MIN** indicators glow.

d. Press B1 to store change and go to next channel, or go to Calibration for that channel (see Chapter 7, Step 4).



STEP 5:
a. Repeat Steps 3 and 4 for Channels 1 through 9 (or, the number of channels in your DC Output).

NOTE: The above illustration shows that the DC Output Channel 0 (indicated by 80) has been programmed to reflect A-N Volts (entry 0 from Table 5.1).

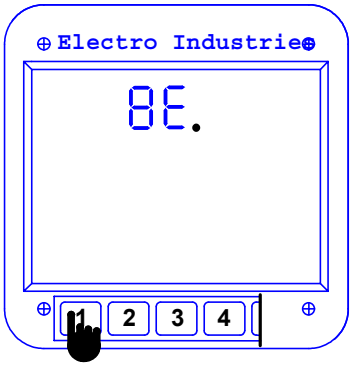


STEP 6:
a. **To Exit**, see Chapter 6, or

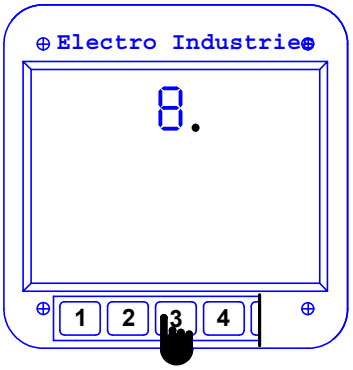
b. Proceed to **Chapter 7: Calibration**

CHAPTER 6
EXITING THE PROGRAMMING MODE

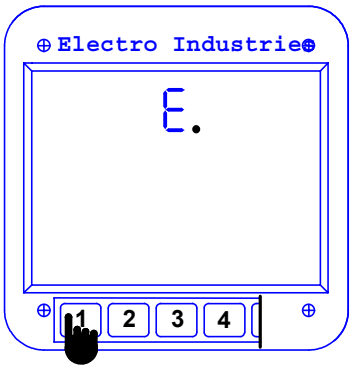
When Exiting the Programming Mode, it is always necessary to store any new changes.



STEP 1:
a. Press **B1** until **8E.** appears.



STEP 2:
a. Press **B3** to exit from Function Level to Group Level.



STEP 3:
a. Press **B1** until **E.** appears.

b. Press **B3** to exit entirely from the Programming Mode.

CHAPTER 7
CALIBRATION

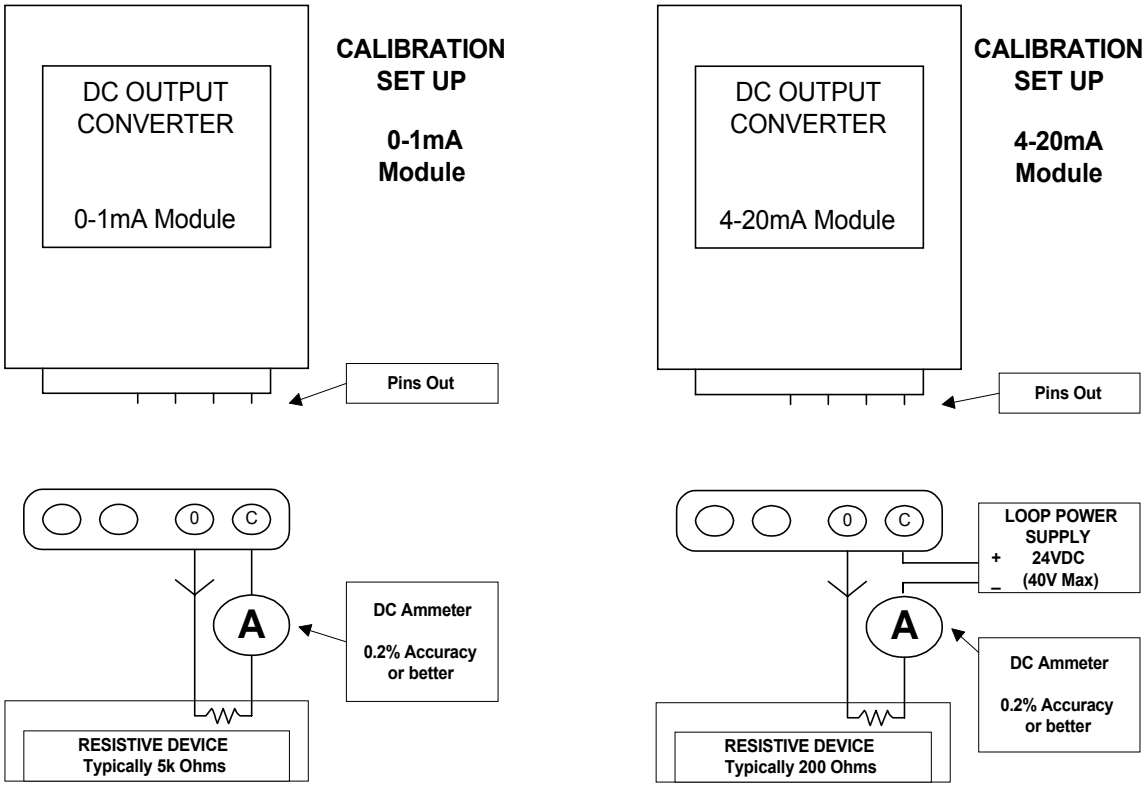


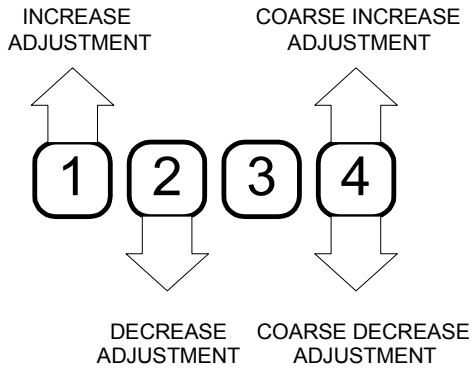
Figure 7.1: Calibration Set Up for All Modules

7.1: Calibration

Calibration is precise adjustment for a particular function. A new DC Output Module is calibrated at the factory to provide the highest accuracy possible. It will also be preset with factory defaults for the channels. (See Chapter 3 for factory defaults for all models.) **Calibration should not be required for any units shipped with a meter or for 6- and 10- Channel DC Analog Outputs.** These modules ship with an EEprom storing the calibration values. The 2- and 4-Channel DC Outputs do not have the EEprom and need to be field calibrated.

This chapter serves as a guide for initial calibration and for the re-calibration of the unit. Before calibrating, a **knowledgeable technician** must connect a DC ammeter to the channel output being calibrated (see Chapter 2: Electrical Installation for channel connection). **Each channel must be calibrated** to ensure accuracy.

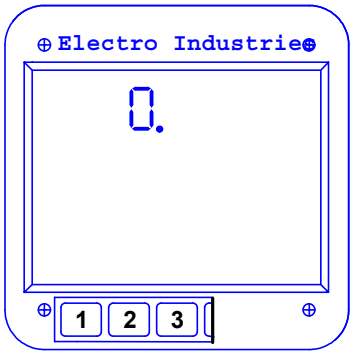
Figure 7.2: Keypad Buttons for Calibration

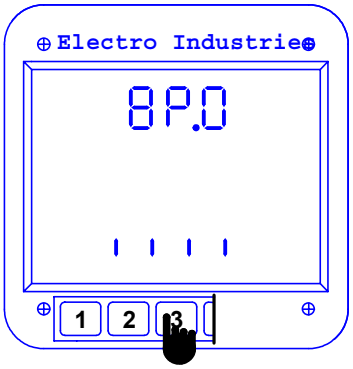


Fine (**B1** and **B2**) and Coarse (**B4**) Adjustments enable the user to change the output in smaller or larger increments. You must press **B1** or **B2** before **B4** will work. It needs to know the direction, Increase or Decrease.

7.2: Low End Calibration

To perform calibration, you must first enter the Programming Mode and select a Channel. You **cannot** enter the Calibration Steps without the preliminary steps.
NOTE: Connect a milliamp meter to the channel being calibrated.



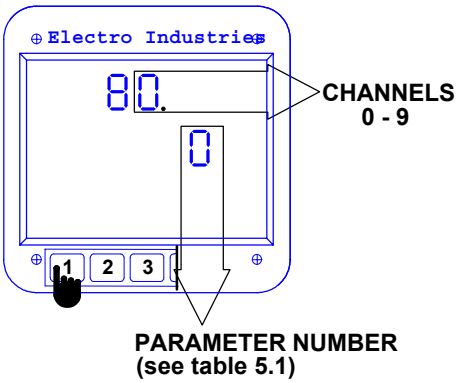


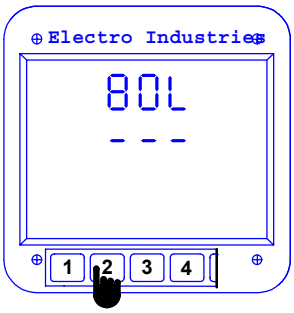
STEP 1:
a. Refer to the Programming Manual of the instrument being programmed. **Enter the Programming Mode.** The above screen should appear.

STEP 2:
a. Press **B1** until Group 8 is reached.

b. Press **B3** to enter DC Output Programming Group.

NOTE: If **8.E** appears on the screen, the meter is not set up for DC Output. Refer to the Programming Manual of the instrument being programmed.





STEP 3: (Channel Mapping)
a. Press **B1** to select a channel.

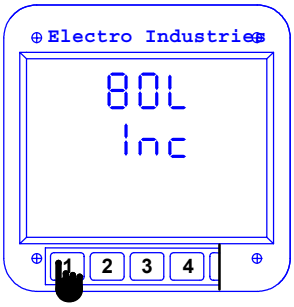
NOTE: Select Channels 0 - 9. The **second digit** corresponds to channel being calibrated or mapped.

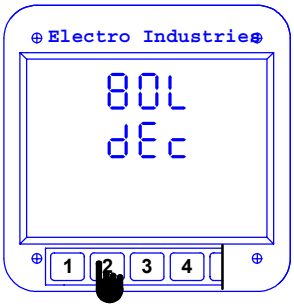
b. Press **B3** to begin Data Entry Sequence. The decimal point disappears from the channel number.

c. Press **B3** until MAX and MIN indicators glow.

STEP 4: (Calibration)
a. Press **B2** to activate Low End Calibration.

NOTE: You must perform Low End Calibration before High End Calibration.





STEP 5:

a. Press **B1** to increase the DC current output (Fine Adjustment).

b. Press **B4** for Coarse Adjustment.

STEP 6:

a. Press **B2** to decrease the DC current output (Fine Adjustment).

b. Press **B4** for Coarse Adjustment.

NOTE: Fine (**B1** and **B2**) and Coarse (**B4**) Adjustments enable the user to change the output in smaller or larger increments. You must press **B1** or **B2** before **B4** will work; it needs to know the direction, Increase or Decrease.

STEP 8:

a. Press **B3** to store when DC ammeter reads exactly:
4 mA or
0 mA - Unidirectional Channel
-1 mA - Bi-directional Channel

(Results depend on model and channel type).

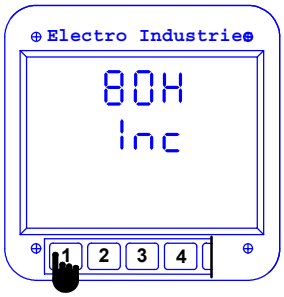
STEP 9:

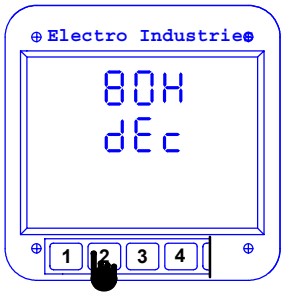
a. Repeat steps for Channels 1-9 (or, for the number of channels in your DC Output Module).

7.3: High End Calibration

High End Calibration is activated upon completion of Low End Calibration. When you press **B3** to store the Low End Calibration, High End Calibration automatically appears.

NOTE: Connect a milliamp meter to the channel being calibrated.





STEP 10:

a. Press **B1** to increase the DC current output (Fine Adjustment).

b. Press **B4** for Coarse Adjustment.

STEP 11:

a. Press **B2** to decrease the DC current output (Fine Adjustment).

b. Press **B4** for Coarse Adjustment.

NOTE: Fine (**B1** and **B2**) and Coarse (**B4**) Adjustments enable the user to change the output in smaller or larger increments. You must press **B1** or **B2** before **B4** will work; it needs to know the direction, Increase or Decrease.

STEP 12:

a. Press **B3** to store when DC ammeter reads exactly:

20 mA or
+ 1 mA - Unidirectional Channel
+ 1 mA - Bi-directional Channel

(Results depend on model and channel type).

STEP 13:

a. Press **B1** to select another Channel. See **Step 3** in Channel Mapping.

b. Repeat steps for Channels 1-9 (or, for the number of channels in your DC Output Module).

See Chapter 6 to Exit.

CHAPTER 8
DMWH DC OUTPUT PROGRAMMING

8.1: DMWH Programming Overview

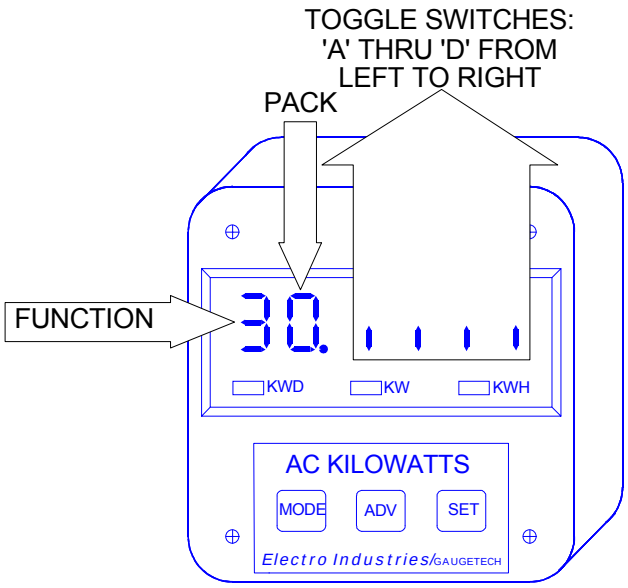
This chapter contains the programming for the basic operation of the DMWH Monitor with a SDFI-1 or SDFI-20 DC Output Module. For further information, see the User's Manual for the DMWH. For further information on parameters, see section 3.3 of this manual.

Programming tasks are arranged into seven GROUPS. Within each GROUP are the specific meter FUNCTIONS. Outlined is the general approach to alter programming mode values.

1. Enter the Programming Mode.
2. Select the desired GROUP.
3. Once the desired GROUP is selected, select a FUNCTION within the GROUP.
4. After the FUNCTION selection, proceed with DATA ENTRY of the new value of the desired parameter.
5. Proceed to program another location and/or exit the programming mode.

IMPORTANT: The full exiting procedure must be followed to store any new programming.

8.2: Switch Packs



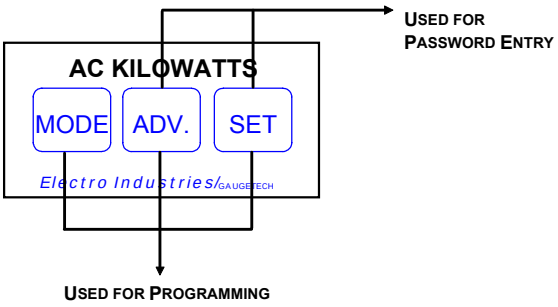
GROUPS, Functions, and Switch PACKS

- GROUPS are the main category.
- Functions are sub categories of GROUPS.
- Switch PACKS are sub categories of FUNCTIONS.

Figure 8.1: DMWH Display Detail

8.3: DMWH Programming Mode Data Entry

Figure 8.2: DMWH 300 Programming Mode uses all three keypads.

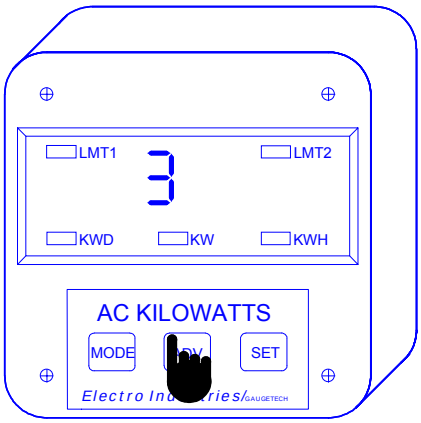


BUTTON	FUNCTION	DESCRIPTION
MODE	ADVANCES	Scrolls groups, functions, and advances to exit point from function and group level.
ADV	CHANGE VALUE	Scrolls packs, digit counters, and changes switch pack position UP or DOWN.
SET	STORE	Activates new data entry and enters or exits from group or function level.

8.4: Password Entry

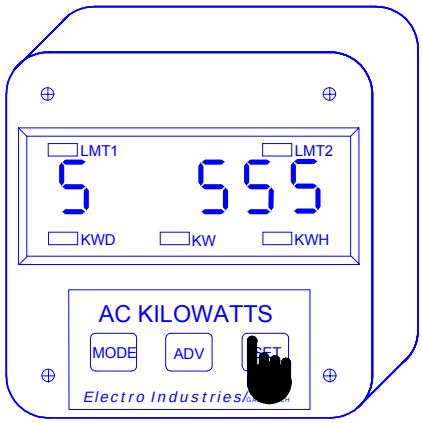
NOTE: To enter the Programming Mode the DMWH must be in the KW mode.

The DMWH 300 is password protected. To enter the Programming Mode, key in the following password. The password is **555**. The password entry may seem awkward at first. It is designed to discourage unauthorized tampering. After the user becomes familiar with password entry, it will be easy to enter.



Step 1:
a. Press **ADV** until 3 appears.

b. Press **SET** to select and **333** flashes momentarily.

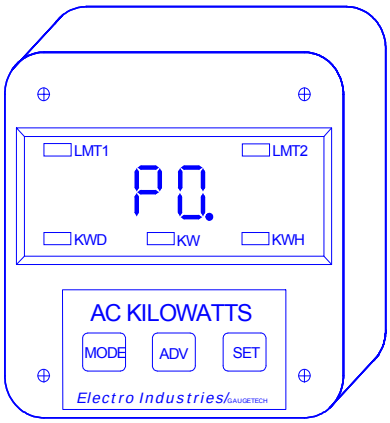


Step 2:
⇨Three dashes appear to the right and digits begin scrolling to the left.

⇨The password is **555**.

a. Press **SET** each time 5 appears.

⇨ Selected digits appear.

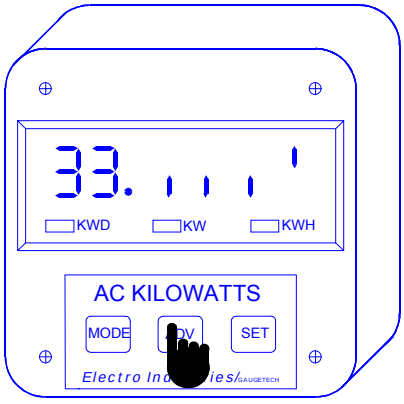


⇨Display blanks and **PPP** flashes, confirming a correctly entered password.

⇨PPP is replaced by **P0.**

b. Press **SET** to activate Programming Mode, **GROUP 0.**

8.5: Programming the DMWH with DC Output Module



Step 3: Enable DC Output Mode

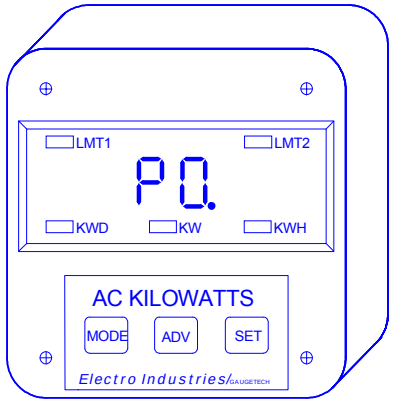
a. Press **MODE** until **30.** appears.

b. Press **ADV** until **33.** appears.

c. Press **SET** to activate Data Entry Sequence.

d. Press **ADV** to toggle **ONLY** last 2 segments to the above positions.

e. Press **SET** to store.



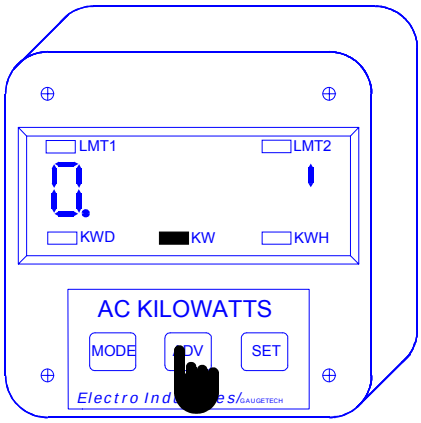
Step 4: Program DC Output Module

a. Press **MODE** until **E.** appears.

b. Press **SET** until **PO.** appears.

c. Press **MODE** to scroll to **P8.**

d. Press **SET** to enter Group 0.



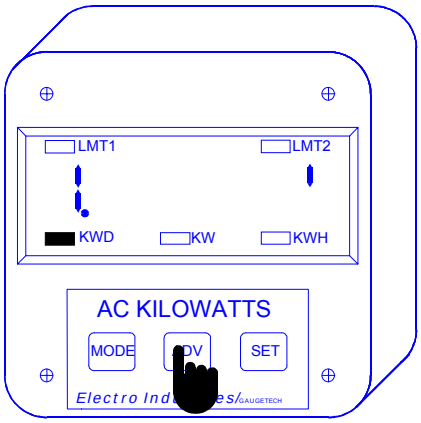
Step 4:

a. Press **SET** to change the vertical Bar under LMT2 to horizontal.

b. Press **ADV** to position the vertical bar in the **UP** position or **DOWN** position.

c. Press **SET** to enter Calibration (see 8.6: Calibration section), or...

d. Press **MODE** to lock in data.



Step 5:

a. Press **MODE** to scroll to **1.**

b. Press **SET** to change the vertical bar under LMT2 to horizontal.

c. Press **ADV** to position the vertical bar in the UP position or **DOWN** position.

d. Press **SET** to enter Calibration (see section 8.6), or press **MODE** to lock in data.

e. Proceed to Exit.

NOTE: Vertical bar position means:
UP = Unidirectional **DOWN = Bi-directional**

8.6: Calibrating the DMWH with DC Output Module

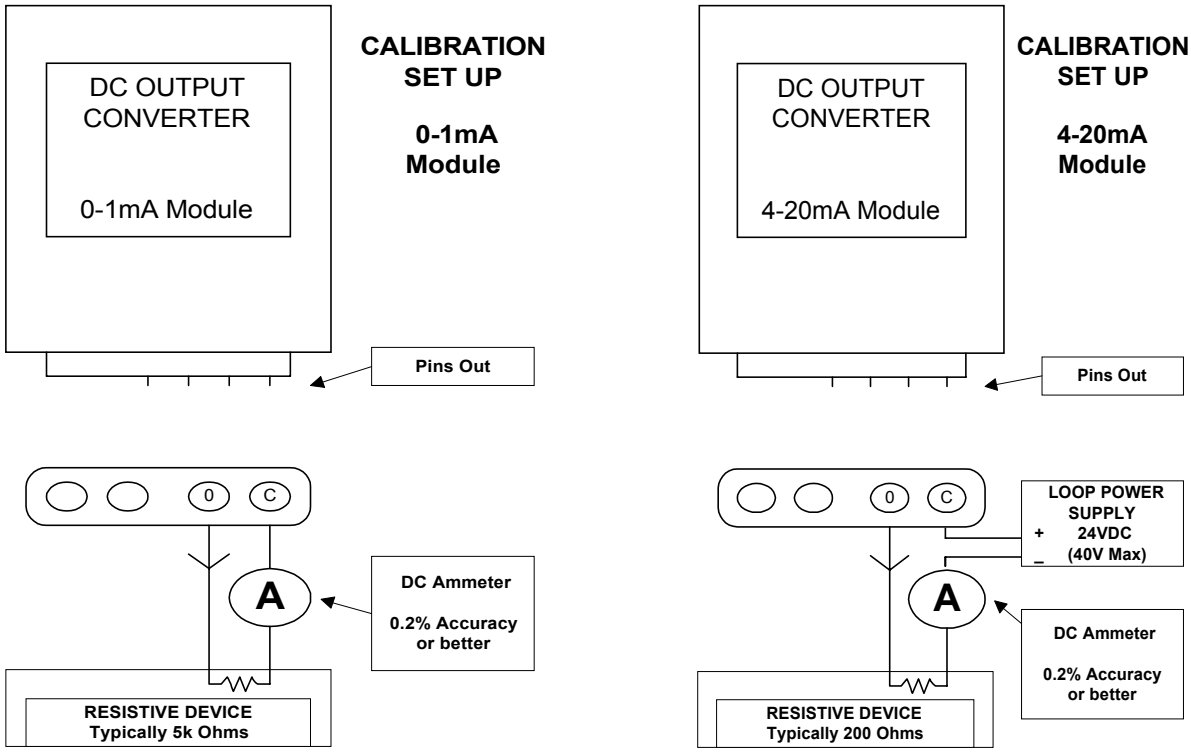
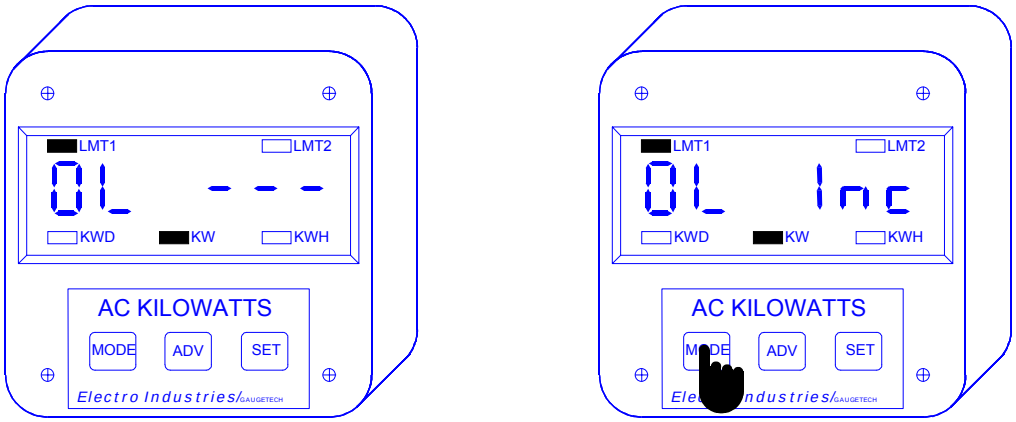


Figure 8.3: Calibration Set Up



Step 1:
a. Press **ADV** and the above screen appears on the display.

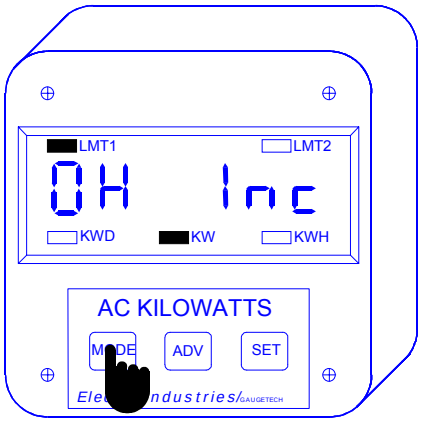
NOTE: This DC Output Module requires calibration because it has no memory. Calibration is the incremental or decremental change of the DC current output.

b. Attach DC ammeter in series with channel to be calibrated.

Step 2: Low End Calibration
a. Press **MODE** to increase DC current output.

b. Press **ADV** to decrease DC current output..

c. Press **SET** to store calibration when DC ammeter reads exactly:
4 mA or
0 mA - Unidirectional Channel
-1 mA - Bi-directional Channel



Step 3: High End Calibration

a. Press **MODE** to increase DC current output.

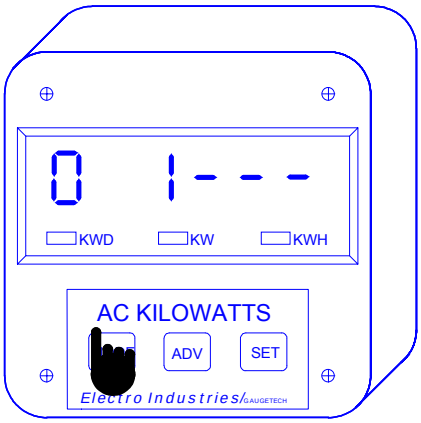
b. Press **ADV** to decrease DC current output..

c. Press **SET** to store calibration DC ammeter reads exactly:
20 mA or
+ 1 mA - Unidirectional
+ 1 mA - Bi-directional

Step 4:
Proceed to Exit.

NOTE:
You should calibrate both channels for the greatest accuracy.

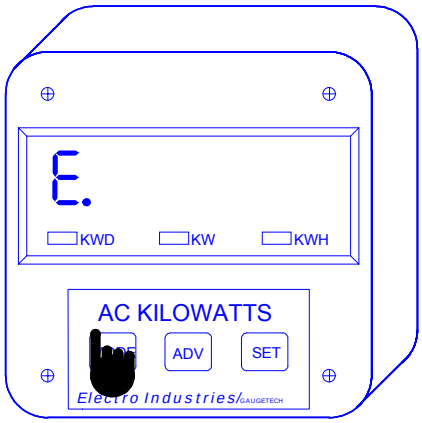
8.7: Exiting the DMWH Programming Mode



Step 1: Exiting from Data Entry Sequence

a. Press **MODE** to cancel the Data Entry Sequence.

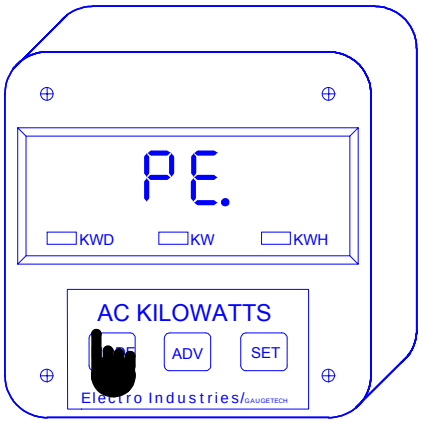
⇨The DMWH returns to the Function Level.



Step 2: Exiting from Function Level

a. Press **MODE** until **E.** appears.

b. Press SET to exit from the Function Level to Group Level.



Step 3: Exiting from Group Level

a. Press **MODE** until **PE.** appears.

b. Press **SET** to exit entirely from the Programming Mode.

⇨You have exited the Programming Mode. The LMT1 and LMT2 lights will flash momentarily to let you know you have exited.

After a moment the meter will return to the Operating Mode.

APPENDIX A

A.1: Enable DC Output Option

Note: If the DC Output Module is purchased separately, the DC Output Option must be enabled. To do that, follow the procedure outlined below: (Procedure applies to DMMS 300+ and DWVA **only**.)

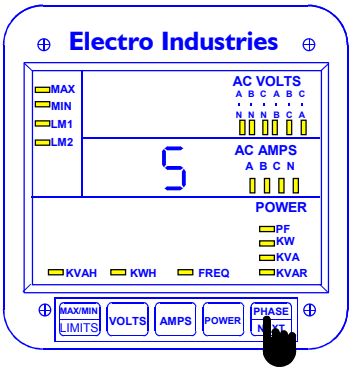
1. **Enable** DC Output Option in the Group 0, Pack 3, Switch D. **Disable** Group 0, Pack 3, Switch C.
2. See the Device's Programming Manual under System Configuration for details of the DC Output Option Enabling Procedure.
3. After enabling the DC Output Option, continue with programming and calibration.

Note: Calibration is required **only** for 2-channel and 4-channel models (IF purchased separately).

A.2: Retrieval of DC Output Calibration & Programming (except 8P0) from SEFI and SHNI

These instructions are necessary **only** if the meter and DC Output Module were not ordered together.

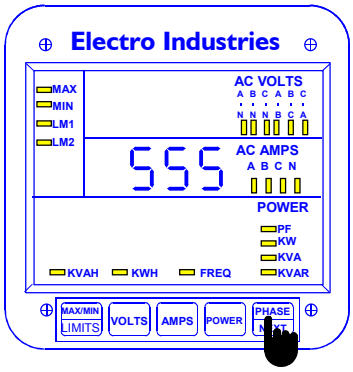
⇨Entering the Programming Mode:



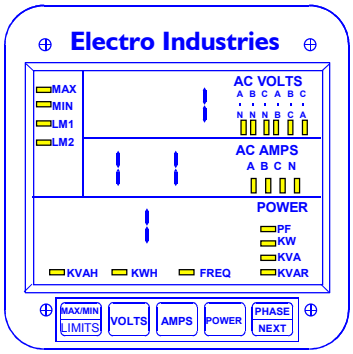
Step 1:
a. Press and hold **PHASE/NEXT**.

b. While holding PHASE/NEXT, press **AMPS** until a single digit number appears in middle display.

c. Release PHASE/NEXT and continue holding AMPS until 5 appears in middle display.



Step 2:
a. Press **PHASE/NEXT** and 555 appears in middle display.



⇨ The placement of the illuminated segments on the screen represents a large **Check Mark**.

This Check Mark indicates that you have retrieved the data successfully.

Table A.1: Standard and Extended Parameters for Channel Mapping

Parameter	Parameter Number
Volts AN	0
Volts BN	1
Volts CN	2
Volts AB (Not available for Wye connection unless specially calibrated)	3
Volts BC (Not available for Wye connection unless specially calibrated)	4
Volts CA (Not available for Wye connection unless specially calibrated)	5
Amps A	6
Amps B	7
Amps C	8
Amps N	9
Total Watts	10
Total VARS	11
VA	12
Power Factor (Bi-directional DC Output must be selected in 8P1)	13
Frequency (Bi-directional DC Output must be selected in 8P1)	14
WATT Phase A (Special Order)	17
WATT Phase B (Special Order)	18
WATT Phase C (Special Order)	19
VAR Phase A (Special Order)	20
VAR Phase B (Special Order)	21
VAR Phase C (Special Order)	22

Table A.2: Parameters Available by Model

MODEL	Parameters																				
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**17**	**18**	**19**	**20**	**21**	**22**
SDFI / 3DWA											X	X	X	X							
SNFI / 3DAA5							X	X	X	X											
SNFI / 3DVA	X	X	X	X	X	X															
SNFI / 3DVA Delta				X	X	X															
SEFI / DWVA							X	X	X	X	X	X				X	X	X	X	X	X
SHNI / DMMS300	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SHNI / DMMS300 Delta				X	X	X	X	X	X		X	X	X	X	X						
SHNI / DWVA							X	X	X	X	X	X				X	X	X	X	X	X

NOTE: DMWH is always programmed Watts and Watts Demand and cannot be changed.

APPENDIX B

B.1: Calculating the Equivalent Analog Output

This Appendix describes how to calculate what the output module should be providing for any given input. These calculations can be used to verify the correct operation and calibration of the meter and output module. For example, you could compare the measured output of a module with the calculated value to determine correct operation or the calibration of an output. The calculations can also be used in troubleshooting and operational testing. This is not calibration. For Calibration of all models except DMWH, refer to Chapter 7. For DMWH Calibration, refer to Chapter 8.

We will use variations of one basic formula to calculate the DC Output based on the Displayed Readings. Throughout this section, we will refer to the list of Formula Terms and the System Example, which are stated below. **Appendix C** provides **Worksheets** for use when performing these calculations.

FORMULA TERMS

Display Reading: The unsigned WATT or VAR reading currently displayed on the meter.

Range: Number of milliamps between 0 and the Parameter Full Scale Output.

Table B.1: Range for 0-1 and 4-20mA Modules

Output	Channel Type	Range
4-20	Unidirectional	16(mA)
4-20	Bi-directional	8(mA)
0-1	Unidirectional	1(mA)
0-1	Bi-directional	1(mA)

Offset: Difference between ZERO POINT and the MODULE OUTPUT of "0mA".

Table B.2: Offset for 0-1 and 4-20mA Modules

Output	Channel Type	Assigned Zero
4-20	Unidirectional	4(mA)
4-20	Bi-directional	12(mA)
0-1	Unidirectional	0(mA)
0-1	Bi-directional	0(mA)

R: A conversion constant based upon the DSP MODULE of the meter in use.

150V Std (standard) = 0.833
300V Suffix "G" = 0.667
75V Suffix "L" = 0.667

SYSTEM VALUES (CONSTANTS) USED FOR ALL EXAMPLES:

System: 3-Phase Wye - 3 elements
Voltage rating (located on the meters' DSP module label) = 150V L-N, 300V L-L
Current rating (located on the meters' DSP module label) = 5 Amperes

PT Ratio = 14400/120 or 120/1
CT Ratio = 200/5

Primary Full Scale Wattage = (Primary voltage) x (Primary current) x (Elements)
= (14400V) X (200A) X (3 elements)
= 8,640,000 = **8.64 MW**

Secondary Full Scale Wattage = (Secondary voltage) x (Secondary current) x (Elements)
= (120V) X (5A) X (3 elements) = **1800W**

Note: Delta = 2 elements Wye = 3 elements

B.1.1: UNIDIRECTIONAL WATT OR VAR DC OUTPUT

Note: This formula applies to Watts or VARS.

$$\text{Analog Module DC Output} = \frac{\text{Display Reading}}{[(\text{PT ratio}) * (\text{CT ratio}) * (\text{Secondary F/S}) * R]} * (\text{Range}) + (\text{Offset})$$

EXAMPLE:

If the Display Reading = 5.00MW and we want to calculate what the module output should be, we would do the following:

Use appropriate calculation for the type of output module to be used.
Based upon Formula Terms and System Values in B.1:

R = 0.833
PT ratio = 120/1
CT ratio = 200/5
Secondary Full Scale = 1800

USING THE 4-20mA MODULE

Range (4-20) = 16(mA) Offset (4-20) = 4(mA)

$$\text{Analog Module DC Output} = \frac{\text{Display Reading}}{[(\text{PT ratio}) * (\text{CT ratio}) * (\text{Secondary F/S}) * R]} * (\text{Range}) + (\text{Offset})$$

$$\frac{5{,}000{,}000}{[(120/1) * (200/5) * (1800) * 0.833]} * (16) + (4)$$

$$= 0.695 * 16 + 4$$
$$= 11.12 + 4$$
$$= 15.12\text{mA}$$

Output Result: If the display is reading 5.00MW, the DC output generates 15.12mA.

USING THE 0-1mA MODULE

Range (0-1) = 1(mA) Offset (0-1) = 0(mA)

$$\text{Analog Module DC Output} = \frac{\text{Display Reading}}{[(\text{PT ratio}) * (\text{CT ratio}) * (\text{Secondary F/S}) * R]} * (\text{Range}) + (\text{Offset})$$

$$\frac{5{,}000{,}000}{[(120/1) * (200/5) * (1800) * 0.833]} * (1) + (0)$$

$$= 0.695 * 1 + 0$$
$$= 0.695\text{mA}$$

Output Result: If the display is reading 5.00MW, the DC output generates 0.695mA.

B.1.2: BI-DIRECTIONAL WATT OR VAR DC OUTPUT

Note: This formula applies to Watts or VARS.

$$\text{Analog Module DC Output} = \frac{\text{Display Reading}}{[(\text{PT ratio}) * (\text{CT ratio}) * (\text{Secondary F/S}) * R]} * (\text{Range}) + (\text{Offset})$$

EXAMPLE:

If the Display Reading = 5.00MW and we want to calculate what the module output should be, we would do the following:

Use appropriate calculation for output module type.
Based upon Formula Terms and System Values in B.1:

R = 0.833
PT ratio = 120/1
CT ratio = 200/5
Secondary Full Scale = 1800

USING THE 4-20mA MODULE

Range (4-20) = 8(mA) Offset (4-20) = 12(mA)

$$\text{Analog Module DC Output} = \frac{\text{Display Reading}}{[(\text{PT ratio}) * (\text{CT ratio}) * (\text{Secondary F/S}) * R]} * (\text{Range}) + (\text{Offset})$$

$$\frac{5{,}000{,}000}{[(120/1) * (200/5) * (1800) * 0.833]} * (8) + (12)$$

$$= 0.695 * 8 + 12$$
$$= 5.56 + 12$$
$$= 17.56\text{mA}$$

Output Result: If the display is reading 5.00MW, the DC output generates 17.56mA.

USING THE 0-1mA MODULE

Range (0-1) = 1(mA) Offset (0-1) = 0(mA)

$$\text{Analog Module DC Output} = \frac{\text{Display Reading}}{[(\text{PT ratio}) * (\text{CT ratio}) * (\text{Secondary F/S}) * R]} * (\text{Range}) + (\text{Offset})$$

$$\frac{5{,}000{,}000}{[(120/1) * (200/5) * (1800) * 0.833]} * (1) + (0)$$

$$= 0.695 * 1 + 0$$
$$= 0.695\text{mA}$$

Output Result: If the display is reading 5.00MW, the DC output generates 0.695mA.

B.1.3: UNIDIRECTIONAL VOLTS

$$\text{Analog Module DC Output} = \frac{\text{Display Reading}}{\text{Voltage Full Scale}} * (F) * (\text{Range}) + (\text{Offset})$$

NOTE: Voltage Full Scale (typically 14400) is programmed by the factory or by the user.

F= Voltage Adjustment Factor = $\frac{\text{Calibrated Voltage}}{\text{Maximum Voltage}}$ (voltage level used in calibration) (as stated on meter label)

F (Std)= $\frac{120}{150}$ = 0.8 F("L")= $\frac{75}{75}$ = 1.0 F("G")= $\frac{300}{300}$ = 1.0

Table B.3: Voltage Specifications by Model

Meter Suffix	Meter Input (PT Secondary)	Module Output	F (Voltage Adjustment Factor)
Standard	0 ..... 150 Volts(secondary)	= 4.000 ..... 20.000 mA	0.8
"L"	0 ..... 75 Volts(secondary)	= 4.000 ..... 20.000 mA	1.0
"G"	0 ..... 300 Volts(secondary)	= 4.000 ..... 20.000 mA	1.0

EXAMPLE: Display Reading = 14.00kV

USING THE 4-20mA MODULE

Range (4-20) = 16(mA) Offset (4-20) = 4(mA)

$$\text{Analog Module DC Output} = \frac{\text{Display reading}}{\text{Voltage Full Scale}} *(F) * (\text{Range}) + (\text{Offset})$$

$$= \frac{14000}{14400} *(0.8) * (16) + (4)$$

$$= 0.972 * 0.8 * 16 + 4$$

$$= 12.44 + 4$$

$$= 16.44 \text{ mA}$$

Output Result: If the display is reading 14.00 kV, the DC output generates 16.44mA.

USING THE 0-1mA MODULE

Range (0-1) = 1(mA) Offset (0-1) = 0(mA)

$$\text{Analog Module DC Output} = \frac{\text{Display reading}}{\text{Voltage Full Scale}} *(F) * (\text{Range}) + (\text{Offset})$$

$$= \frac{14000}{14400} * (0.8) * (1) + (0)$$

$$= 0.972 * 0.8 * 1 + 0$$

$$= 0.777$$

$$= 0.777 \text{ mA}$$

Result: If the display is reading 14.00 kV, the DC output generates 0.777mA.

B.1.4: UNIDIRECTIONAL AMPERES

$$\textit{Analog Module DC Output} = \frac{\textit{Display reading}}{\textit{Ampere Full Scale}} * (\textit{Range}) + (\textit{Offset})$$

NOTE: Ampere Full Scale (typically 200) is programmed by the factory or by the user.

Table B.4: Ampere Specifications

Meter Input (CT Secondary)	Module Output
0 ..... 5A(secondary)	= 4.000 ..... 20.000 mA (4-20mA)
0 ..... 5A(secondary)	= 0 ..... 1.000 mA (0-1mA)

EXAMPLE: Display Reading = 120 A

USING THE 4-20mA MODULE

Range (4-20) = 16(mA) Offset (4-20) = 4(mA)

$$\textit{Analog Module DC Output} = \frac{\textit{Display reading}}{\textit{Ampere Full Scale}} * (\textit{Range}) + (\textit{Offset})$$

$$= \frac{120}{200} * (16) + (4)$$

$$= 0.600 * 16 + 4$$

$$= 9.60 + 4$$

$$= 13.60\ mA$$

Output Result: If the display is reading 120A, the DC output generates 13.60mA.

USING THE 0-1mA MODULE

Range (0-1) = 1(mA) Offset (0-1) = 0(mA)

$$\textit{Analog Module DC Output} = \frac{\textit{Display reading}}{\textit{Ampere Full Scale}} * (\textit{Range}) + (\textit{Offset})$$

$$= \frac{120}{200} * (1) + (0)$$

$$= 0.600 * 1 + 0$$

$$= 0.600$$

$$= 0.600\ mA$$

Output Result: If the display is reading 120A, the DC output generates 0.600mA.

B.1.5: BI-DIRECTIONAL FREQUENCY 60 HZ

Note: Input Range is the Frequency range as compared to the DC output. The Input Range is "5.00" because it will deviate ±5Hz on either side of the center frequency of 60Hz.

55-60-65Hz = 4-12-20mA

$$\textit{Analog Module DC Output} = \frac{\textit{(Display Reading – 60)}}{\textit{Input Range}} * \textit{(Range) + (Offset)}$$

EXAMPLE: DISPLAY READING = 62.00HZ

USING THE 4-20mA MODULE

Range (4-20) = 8(mA) Offset (4-20) = 12(mA)

$$\textit{Analog Module DC Output} = \frac{\textit{(Display Reading – 60)}}{\textit{Input Range}} * \textit{(Range) + (Offset)}$$

$$= \frac{(62 – 60)}{5} * (8) + (12)$$

$$= \frac{2}{5} * (8) + (12)$$

$$= 0.4 * (8) + (12)$$

$$= 3.2 + 12$$

$$= 15.2mA$$

Output Result: If the display is reading 62Hz, the DC output generates 15.20mA.

USING THE 0-1mA MODULE

Range (0-1) = 1(mA) Offset (0-1) = 0(mA)

$$\textit{Analog Module DC Output} = \frac{\textit{(Display Reading – 60)}}{\textit{Input Range}} * \textit{(Range) + (Offset)}$$

$$= \frac{(62 – 60)}{5} * (1) + (0)$$

$$= \frac{2}{5} * (1) + (0)$$

$$= 0.4mA$$

Output Result: If the display is reading 62Hz, the DC output generates 0.400mA.

B.1.6: BI-DIRECTIONAL POWER FACTOR

Note: Input Power Factor Range as compared to the DC Output Range.
The Input Range is "0.500" because it will deviate by a power factor of ±0.500 on either side of the center power factor of 1.000.

- 0.500 - ±1.000 - +0.500 = 4-12-20mA

$$\text{Analog Module DC output} = (\text{PF sign}) \frac{(1.000 - \text{Display Reading})}{\text{Input Power Factor Range}} * (\text{Range}) + (\text{Offset})$$

EXAMPLE: PF = +0.866

USING THE 4-20 MODULE

Range (4-20) = 8(mA) Offset (4-20) = 12(mA)

$$\text{Analog Module DC Output} = (\text{PF sign}) \frac{(1.000 - \text{Display Reading})}{\text{Input Power Factor Range}} * (\text{Range}) + (\text{Offset})$$

$$= (+)\frac{(1.000 - 0.866)}{0.500} * (8) + (12)$$

$$= (+)0.268 * (8) + (12)$$

$$= 14.144\text{mA}$$

Output Result: If the display is reading +0.866, the DC output generates 14.144mA.

USING THE 0-1mA MODULE

Range (0-1) = 1(mA) Offset (0-1) = 0(mA)

$$\text{Analog Module DC Output} = (\text{PF sign}) \frac{(1.000 - \text{Display Reading})}{\text{Input Power Factor Range}} * (\text{Range}) + (\text{Offset})$$

$$= (+)\frac{(1.000 - 0.866)}{0.500} * (1) + (0)$$

$$= (+)0.268 * (1) + (0)$$

$$= +0.268\text{mA}$$

Output Result: If the display is reading +0.866, the DC output generates +0.268mA.

In this Appendix, we have demonstrated the formulas that verify the Analog Output. For programming of all DC Output Modules (except SDFI/DMWH) refer to Chapter 4 of this manual. For programming of the SDFI with the DMWH meter, refer to Chapter 8 of this manual.

Please see the following **DC Output Worksheet**, which will guide you through the utilization of the above Formulas, Terms and Examples to verify your DC Output.

APPENDIX C

C.1: DC Output Worksheet

This WORKSHEET will guide you through the utilization of the Formulas, Terms and Examples in Appendix B to calculate the DC Output based on the Displayed Readings. Throughout this worksheet, we will refer to the list of Formula Terms and the System Example, which are stated below.

FORMULA TERMS

Display Reading: The unsigned WATT or VAR reading currently displayed on the meter.

Range: Number of milliamps between 0 and the Parameter Full Scale Output.

Table C.1: Range for 0-1 and 4-20mA Modules

Output	Channel Type	Range
4-20	Unidirectional	16(mA)
4-20	Bi-directional	8(mA)
0-1	Unidirectional	1(mA)
0-1	Bi-directional	1(mA)

Offset: Difference between ZERO POINT and the MODULE OUTPUT of "0mA".

Table C.2: Offset for 0-1 and 4-20mA Modules

Output	Channel Type	Assigned Zero
4-20	Unidirectional	4(mA)
4-20	Bi-directional	12(mA)
0-1	Unidirectional	0(mA)
0-1	Bi-directional	0(mA)

R factor: A conversion constant for the voltage back module in use.

150V Std (standard) = 0.833
300V Suffix "G" = 0.667
75V Suffix "L" = 0.667

SYSTEM VALUES (CONSTANTS) USED FOR EXAMPLES:

System Elements = (2) or (3) measured phases
Voltage Rating (located on the meters' DSP module label) = _____
Current Rating (located on the meters' DSP module label) = _____

PT Ratio = _____
CT Ratio = _____

Primary Full Scale Wattage = (Primary voltage) x (Primary current) x (# of Elements)
= (_____) X (_____) X (_____) = _____
= _____

Secondary Full Scale Wattage = (Secondary voltage) x (Secondary current) x (# of Elements)
= (_____) X (_____) X (_____)
= _____

Note: Delta = 2 elements Wye = 3 elements

C.1.1: UNIDIRECTIONAL WATT OR VAR DC OUTPUT

Note: This formula applies to Watts or VARS.

4-20 MODULE CALCULATION

Analog Module DC Output = *Display Reading* *(Range) +(Offset)
*[(PT ratio) * (CT ratio)* (Secondary F/S) * R]*

_____*(_____) +(_____)
*[(_____) * (_____)* (_____) *_____]*

= _____ *_____ +_____= _____ + _____= _____

0-1mA CALCULATION

Analog Module DC Output = *Display Reading* *(Range) +(Offset)
*[(PT Ratio) * (CT Ratio)* (Secondary F/S) * R]*

_____*(_____) +(_____)
*[(_____) * (_____)* (_____) *_____]*

= _____ *_____ +_____ = _____

C.1.2: BI-DIRECTIONAL WATT OR VAR DC OUTPUT

Note: This formula applies to Watts or VARS.

4-20mA MODULE CALCULATION

Analog Module DC Output = *Display Reading* *(Range) +(Offset)
*[(PT Ratio) * (CT Ratio)* (Secondary F/S) * R]*

_____*(_____) +(_____)
*[(_____) * (_____)* (_____) *_____]*

= _____ *_____+_____ =_____ + _____= _____

0-1mA MODULE CALCULATION

Analog Module DC Output = *Display Reading* *(Range) +(Offset)
*[(PT ratio) * (CT ratio)* (Secondary F/S) * R]*

_____*(_____) +(_____)
*[(_____) * (_____)* (_____) * _____]*

= _____ *_____ +_____ = _____

C.1.3: UNIDIRECTIONAL VOLTS

Analog Module DC Output = $\frac{\textit{Display reading}}{\textit{Voltage Full Scale}}$ ** (F) * (Range) + (Offset)*

NOTE: Voltage Full Scale (typically 14400) is programmed by the factory or by the user.

F= Voltage Adjustment Factor = $\frac{\text{Calibrated Voltage}}{\text{Maximum Voltage}}$ (voltage level used in calibration) (as stated on meter label)

F (Std)= $\frac{120}{150}$ = 0.8 F("L")= $\frac{75}{75}$ = 1.0 F("G")= $\frac{300}{300}$ = 1.0

Table C.3: Voltage Specifications by Model

Meter Suffix	Meter Input (PT Secondary)	Module Output	F (Voltage Adjustment Factor)
Standard	0 ..... 150 Volts(secondary)	= 4.000 ..... 20.000 mA	0.8
"L"	0 ..... 75 Volts(secondary)	= 4.000 ..... 20.000 mA	1.0
"G"	0 ..... 300 Volts(secondary)	= 4.000 ..... 20.000 mA	1.0

4-20mA MODULE CALCULATION

Analog Module DC Output = $\frac{\textit{Display reading}}{\textit{Voltage Full Scale}}$ **(F) * (Range) + (Offset)*

_____* (_____)* (_____) + (_____)
(_____)

= _____* _____*_____+_____=_____=_____

0-1mA MODULE CALCULATION

Analog Module DC Output = $\frac{\textit{Display reading}}{\textit{Voltage Full Scale}}$ **(F) * (Range) + (Offset)*

_____* (_____) * (_____) + (_____)
(_____)

= _____ *_____ *_____ +_____= _____= _____

C.1.4: UNIDIRECTIONAL AMPERES

Analog Module DC Output = $\frac{\textit{Display reading}}{\textit{Ampere Full Scale}}$ ** (Range) + (Offset)*

NOTE: Ampere Full Scale (typically 200) is programmed by the factory or by the user.

Table C.4: Ampere Specifications

Meter Input (CT Secondary)	Module Output
0 ..... 5A(secondary)	= 4.000 ..... 20.000 mA (4-20ma)
0 ..... 5A(secondary)	= 0 ..... 1.000 mA (0-1ma)

4-20mA MODULE CALCULATION

Analog Module DC Output = $\frac{\textit{Display reading}}{\textit{Ampere Full Scale}}$ ** (Range) + (Offset)*

$\frac{(\_\_\_\_\_)}{(\_\_\_\_\_)}$ ** (_____) + (_____)*

= _____ *_____ + _____ = _____ + _____ = _____

0-1mA MODULE CALCULATION

Analog Module DC Output = $\frac{\textit{Display reading}}{\textit{Ampere Full Scale}}$ ** (Range) + (Offset)*

$\frac{(\_\_\_\_\_)}{(\_\_\_\_\_)}$ ** (_____) + (_____)*

= _____ *_____ + _____ = _____ = _____

C.1.5: BI-DIRECTIONAL FREQUENCY 60 HZ

Note: Input Range is the Frequency range as compared to the DC output. The Input Range is "5.00" because it will deviate ±5Hz on either side of the center frequency of 60Hz.
For example: 55-60-65Hz = 4-12-20mA.

Bi-directional Frequency DC output = $\frac{\textit{(Display Reading – 60)}}{\textit{Input Range}}$ ** (Range) + (Offset)*

4-20mA MODULE CALCULATION

Bi-directional Frequency DC output = $\frac{\textit{(Display Reading – 60)}}{\textit{Input Range}}$ ** (Range) + (Offset)*

$\frac{(\_\_\_\_\_)}{(\_\_\_\_\_)}$ * (_____) + (_____)

= _____* (_____) + (_____) = _____ + _____ = _____

0-1mA MODULE CALCULATION

Analog Module DC Output = $\frac{\text{(Display Reading – 60)}}{\text{Input Range}}$ * (Range) + (Offset)

$\frac{(\_\_\_\_\_)}{(\_\_\_\_\_)}$ * (_____) + (_____)

= $\frac{(\_\_\_\_\_)}{}$ * (_____) + (_____) = _____

C.1.6: BI-DIRECTIONAL POWER FACTOR

Note: Input Range is the Power Factor range as compared to the DC output. The Input Range is ".500" because it will deviate by a power factor of ±0.500 on either side of the center power factor of 1.000.

For example: -0.500 - ±1.000 - +0.500 = 4-12-20mA.

Analog Module DC Output = (PF sign) $\frac{\text{(1.000-Display Reading)}}{\text{Input Power Factor Range}}$ * (Range) + (Offset)

4-12-20 CALCULATION

Analog Module DC Output = (PF sign) $\frac{\text{(1.000-Display Reading)}}{\text{Input Power Factor Range}}$ * (Range) + (Offset)

(+)$\frac{(\_\_\_\_\_)}{(\quad)}$ * (_____) + (_____)

= (+)_____ * (_____) + (_____) = _____

0-1mA MODULE CALCULATION

Analog Module DC Output = (PF sign) $\frac{\text{(1.000-Display Reading)}}{\text{Input Power Factor Range}}$ * (Range) + (Offset)

= (+)$\frac{(\_\_\_\_\_)}{(\quad)}$ * (_____) + (_____)

= (+)_____ * (_____) + (_____) = _____