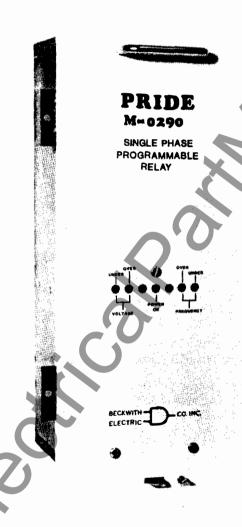




Specifications

# PRIDE Voltage & Frequency Relay Single-Phase M-0290



# Protective Relay for Interconnection of Dispersed Energy

- To disconnect Dispersed Storage and Generation (DSG) when the continued use of the DSG would adversely affect the utility or other customers on the distribution circuit.
- o As a permissive relay to permit reconnection of DSG when the distribution/transmission line voltage has been normal for a period longer than the longest automatic reclosing cycle in use by the utility.
- As a general purpose relay for any combination of the following functions: Overvoltage, undervoltage, over frequency and under frequency.

	FUNCTION	WANTINDEE KAMEES	ACCURACI
1.	Undervoltage	97%,96%,95%,94%,90%,85%,80% of 120 V	±2%
2.	Overvoltage	103%,104%,105%,106%,110%,115%,120% of 120	V ±2%
3.	Under Frequency	59.9 to 55 Hz in 0.1 Hz increments	±.02 Hz
4.	Over Frequency	60.1 to 65 Hz in 0.1 Hz increments	±.02 Hz
5.	Undervoltage Trip Timer*	1 to 9999 cycles in 1 cycle increments	**
6.	Overvoltage Trip Timer*	1 to 9999 cycles in 1 cycle increments	**
7.	Under Frequency Trip Timer*	1 to 9999 cycles in 1 cycle increments	**
8.	Over Frequency Trip Timer*	1 to 9999 cycles in 1 cycle increments	**
9.	Reconnect Timer*	0 to 1092 sec in 1 sec increments	***

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#### NOTE:

- \* The time delay specified is an intentional delay added to the inherent measurement time of the PRIDE®Relay. The total time delay for tripping or reclosing is the sum of the appropriate delay as specified in 5, 6, 7, 8 or 9 plus the measurement time of the unit. The measurement time delay is dependent on the input conditions. The M-0290 voltage measurement time delay, for a loss of input, can vary from 3 to 6 cycles for undervoltage settings of 95% to 80%.
- \*\* Value in cycles is based on an internal 60 Hz timer accurate to 1/2 cycle or ±1% of setting, whichever is greater (refer to note \* above).
- \*\*\* Value in seconds is based on an internal 60 Hz timer accurate to 1/2 second or  $\pm 1\%$  of setting, whichever is greater (refer to note \* above).

#### USER ADJUSTMENTS

In order to provide a minimum cost system, the FRIDE Relay is available without user adjustments for the nine functions listed above. The desired limits for these functions must be specified on the purchase order. The setpoints for all but the Undervoltage or Overvoltage function may be changed at any time by addition of an optional M-0297/M-0397 Field Adjustment Unit which is easily installed by the user. (The Undervoltage or Overvoltage setpoints may be changed through a minor hardware modification). The Field Adjustment Unit can also be used to monitor conditions such as line frequency and timer progress, to enable certain functions, as well as interrogating setpoints or trip targets.

When ordering the PRIDE Relay with the Field Adjustment Unit, the user must specify a set of fixed backup settings that will be used if the M-0397 is later removed from the PRIDE.

If the optional M-0297/M-0397 Unit is not purchased and the user wishes to change PRIDE settings, the old Memory Board model M-0298 containing the settings can be exchanged for a new one that can be installed by the user. Alternatively, additional Memory Boards are available separately from the factory.

#### POWER INPUT

Ac Supply: 80 to 140 V ac, 60 Hz ±10 Hz, 20 W max. will withstand 170 V ac for 5 sec.

Dc Supply: Nominal input voltage 125 V dc, 48 V dc, or 24 V dc; 25 W max. The FRIDE will operate from approximately 65% to 128% of the nominal input voltage and will withstand 150% of nominal voltage for 5 sec. Operation from 250 V dc is possible, but requires the external M-0319 Dropping Regulator Option to provide 125 V dc nominal input voltage to the PRIDE.

#### CAPACITOR POWER HOLD-UP OPTION

Provides power for operation of Ac Supply PRIDE Units for up to 3 sec after loss of input power.

#### SENSING INPUT

0 to 160 V ac at 60 Hz ±15 Hz. 1 W maximum.

#### OUTPUTS

Isolated Trip contact: The user must choose between the Standard, Alternate or Pulse output relay configurations which will determine if the output relay is energized or de-energized in the Trip state. The Trip state is defined as when any parameter is out of specification after the appropriate time delay. The Close state is defined as when all conditions are within acceptable ranges and the reconnect time is complete.

Standard Relay Configuration: The output relay will de-energize when the PRIDE is in the Trip state, and energize when in the Close state.

Alternate Relay Configuration: The output relay will energize when the PRIDE is in the Trip state, and de-energize when in the Close state.

Pulse Relay Configuration: The output relay will pulse energize for 0.5 sec when the PRIDE is in the Trip state, and will remain de-energized in the Close state.

When power to the unit is lost or a Self-Test error is detected, the output relay will de-energize. This is the Trip state in the Standard Relay Configuration and the Close state in the Alternate or Pulse Relay Configuration.

The Standard Relay Configuration was designed to trip the unit when power is lost or when a Self-Test error occurs. The Alternate Relay Configuration is used to prevent tripping due to loss of power or failures detected in the Self-Test routines. The Pulse Relay Configuration can be used in circuit breaker applications where the user wants the trip signal to be momentary.

The user must also choose the type of contact desired (i.e. Normally Open or Normally Closed) in the Trip state. The contact type can be changed by the user if required.

Contact Rating: 6 A at 250 V ac, 80% P.F. make and break; 10 A at 120 V ac, 80% P.F. make and break; 5 A at 125 V dc make and carry only. Output contacts are not rated for interruption of dc circuits unless external arc suppression is used. Consult the factory for advice concerning dc interruption.

Power Loss Contact: This is a normally closed contact that opens when the correct supply voltages are present and the supply is operating properly.

#### LED INDICATORS

The POWER OK LED will remain on as long as power is applied to the unit and the power supply is operating properly. All other LEDs will remain off when conditions are within limits. Appropriate LEDs will light when an over or under limit condition occurs.

UNDERVOLTAGE
OVERVOLTAGE
POWER OK
OVER FREQUENCY
UNDER FREQUENCY

If an error is detected in the Self-Test routine of the microprocessor, an LED will flash indicating the source of the error. In addition, if the unit is purchased with the optional M-0297/M-0397 Field Adjustment Unit, the status LEDs can also be used to display trip target conditions by activating a pushbutton. Refer to the PRIDE Instruction Book for further details.

#### TESTING FEATURE

The M-0290 can be disconnected from the system inputs, using an internal connector, to allow complete functional testing off-line.

#### M-0315 TEST ADAPTER OPTION

The M-0315 can be purchased to ease the functional testing of the M-0290. The Test Adapter consists of a phenolic enclosure containing 14 five-way binding posts and a five foot extension cable with two

polarized plugs that connect to the PRIDE\*Power Input section. The color coded binding posts are labeled to directly correspond to the rear terminal block connectors of the M-0290.

#### TRANSIENT PROTECTION

The input and the output contacts will withstand 1500 V ac, 60 Hz to chassis for one minute. The relay will meet ANSI C37.90-1971 standard on protective relays. In addition, the input and output are electrically isolated from each other and will withstand the ANSI C37.90a-1974 Surge Withstand Capability and Fast Transient Tests.

#### MOUNTING

The M-0290 is designed for either surface mounting or for semiflush mounting. Units specified for surface mounting will be provided with a short cable and terminal block extending below the unit. Units specified for semiflush mounting will be provided with the terminal block mounted to the rear surface. The mounting is also field changeable.

#### ENVIRONMENTAL

Temperature: -40° C to +80° C. Stated accuracies are maintained over this range,

Humidity: Stated accuracies are maintained under 85% relative humidity.

Fungus Resistance: A conformal circuit board coating inhibits fungus growth.

#### APPROXIMATE WEIGHT

15 1b (6.80 kg)

#### APPROXIMATE SHIPPING WEIGHT

17 1b (7.70 kg)

# **OPTIONS**

# PRIDE® VOLTAGE & PREQUENCY RELAY

#### SINGLE-PHASE M-0290

The options for the M-0290 are listed below. If you are ordering a unit, please check the options desired and include a copy of this form with your purchase order. Beckwith Electric will maintain a copy on file as a record of your unit. A sticker with the function settings will be mounted on the inside wall of the unit. If you have received a unit, please check to see that the settings indicated agree with those ordered. The serial number on the CERTIFICATION page and on the unit should agree.

DOVIDD TANDOM	Y	ES	NO
POWER INPUT			
AC SUPPLY	]	]	[ ]
CAPACITOR POWER HOLD-UP OPTION (Ac Supply Units Only)	1	]	[ ]
DC SUPPLY Nominal Dc Voltage V dc (125 V dc, 48 V dc or 24 V dc)	Į	1	[ ]
M-0319 DROPPING REGULATOR Required for operation from 250 V dc. (Specify 125 V dc for Nominal Dc Voltage)	ľ	]	[ ]
OUTPUT RELAYS	OP	EN	CLOSED
OUTPUT CONTACT*	ι	1	[ ]
NOTE: * Output Relay in Tripped State i.e., conditions out	side	o£	setpoints
MOUNTING	Y	ES	NO
MOUNTING SURFACE MOUNT		ES ]	
	[		
SURFACE MOUNT	[	]	[ ]
SURFACE MOUNT SEMIFLUSH MOUNT	]	]	[ ]
SURFACE MOUNT SEMIFLUSH MOUNT PIELD ADJUSTMENT UNIT	1	]	[ ] [ ]
SURFACE MOUNT  SEMIFLUSH MOUNT  PIELD ADJUSTMENT UNIT  M-0297 PRIDE Control Unit	1	]	[ ]
SURFACE MOUNT  SEMIFLUSH MOUNT  PIELD ADJUSTMENT UNIT  M-0297 PRIDE Control Unit  M-0397 EE PROM Board	[	]	[ ]

# **SETPOINTS**

# PRIDE® VOLTAGE & FREQUENCY RELAY

#### SINGLE-PHASE M-0290

If you <u>do not</u> order the M-0297/M-0397 Field Adjustment Unit installed in the PRIDE, ignore the right-hand column below and fill in the setpoint values for the functions shown in the left-hand column. Your settings will then be programmed into the PRIDE at the factory.

If you do order the M-0297/M-0397 to allow the setpoints to be field adjustable, a set of fixed backup settings is also programmed into the PRIDE to be used if the Field Adjustment Unit is later removed. If the FACTORY SETTINGS shown in the right-hand column are acceptable, you need not fill out the CUSTONER SETTINGS. Otherwise, fill in the desired settings in the left-hand column. The Overvoltage and Undervoltage setpoints are not adjustable using the M-0297/M-0397 and must be supplied by the user.

CUSTOMER SETTINGS				~ C	E	ACTO	RY S	<u>ETTIN</u>	SS	
UNDERVOLTAGE SETPOINT	_% of 120	0 V *			Must	be	supp	lied b	y user	
OVERVOLTAGE SETPOINT	% of 12	0 V *		10.	Must	be	supp.	lied b	y user	
UNDER FREQUENCYHZ							<b>59</b> 1	ΗZ		
OVER FREQUENCYHZ		1					61 1	HZ		
UNDERVOLTAGE TRIP TIMER	C YC						30	CYC		
OVERVOLTAGE TRIP TIMER	_CYC						10 (	CYC		
UNDER FREQUENCY TRIP TIMER	CY	c					30	CYC		
OVER FREQUENCY TRIP TIMER	CYC						30	CYC		
RECONNECT TIMERSEC		,					1 :	SEC		
RELAY CONFIGURATION		_								
	YE	S	NO	1		YE	S	МО		
STANDARD	[	1	[	1		[ X	1	ι	]	
ALTERNATE	]	]	I	1		[	]	[ X	]	
PULSE	1	3	[	1		I	1	[ X	]	
						, ,				
NOTE: * The Overvoltage Undervoltage setpoint, i.e										
using an input voltage										
percentages to a base volt	age of	120 V	<b>7.</b>							
<b>.</b>										
Signature				<u></u>					<del></del>	
Company										
Your Purchase Order No		<del></del>								
Date									10	15

# **CERTIFICATION**

This manual contains the most current and complete information available for the following piece of Beckwith Electric equipment.

MODEL NUMBER PRIDE® Voltage & Frequency Relay Single-Phase M-0290
UNIT SERIAL NUMBER
(Stamped on metal plate mounted on rear of unit.)
MEMORY BOARD SERIAL NUMBER (Stamped on printed circuit board.)
SOFTWARE VERSION NUMBER (Stamped on ROM Chips.)
EE PROM BOARD SERIAL NUMBER(Stamped on printed circuit board.)
SOFTWARE VERSION NUMBER (Stamped on ROM Chips.)
CHECKED BY

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# PERSONNEL SAFETY PRECAUTIONS

The following general rules and other specific warnings throughout the manual must be followed during application, test or repair of this equipment. Failure to do so will violate standards for safety in the design, manufacture and intended use of the product. Beckwith Electric Co., Inc. assumes no liability for the customer's failure to comply with these requirements.

#### ALWAYS GROUND THE EQUIPMENT

To avoid possible shock hazard, the chassis must be connected to an electrical ground. When servicing equipment in a test area, the chassis must be attached to a separate ground since it is not grounded by external connections.

#### DO NOT OPERATE IN AN EXPLOSIVE ENVIRONMENT

Do not operate this equipment in the presence of flammable or explosive gases or fumes. To do so would risk a possible fire or explosion.

#### KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove the metal cover or expose the printed circuit board while power is applied. In no case may components be replaced with power applied. In some instances, dangerous voltages may exist even when power is disconnected. To avoid electrical shock, always disconnect power and discharge circuits before working on the unit.

# EXERCISE CARE DURING INSTALLATION, OPERATION AND MAINTENANCE PROCEDURES

The equipment described in this manual contains voltages high enough to cause serious injury or death. Only qualified personnel should install, operate, test and maintain this equipment. Be sure that all personnel safety procedures are carefully followed. Exercise due care when operating or servicing alone.

#### DO NOT MODIFY EQUIPMENT

Do not perform any unauthorized modifications on this instrument. Return of the unit to a Beckwith Electric repair facility is preferred. If authorized modifications are to be attempted, be sure to follow replacement procedures carefully to assure that safety features are maintained.

# A PRODUCT CAUTIONS

Before attempting any test, calibration or maintenance procedure, personnel must be completely familiar with the particular circuitry of this unit and have an adequate understanding of field effect devices. If a component is found to be defective, always follow replacement procedures carefully to assure safety features are maintained. Always replace components with those of equal or better quality as shown in the Parts List of the Instruction Book.

# AVOID STATIC CHARGE

If this unit contains MOS circuitry, it can be damaged by improper test or rework procedures. Care should be taken to avoid static charge on work surfaces and service personnel.

#### USE CAUTION WHEN MEASURING RESISTANCES

Any attempt to measure resistances between points on the printed circuit board, unless otherwise noted in the Instruction Book, is likely to cause damage to the unit.

# TABLE OF CONTENTS

# PRIDE® VOLTAGE & FREQUENCY RELAY SINGLE-PHASE M-0290

ntroduction	.1
The Need	
Background	
	-
pplication	. 2
Relaying Functions	
Kerujing rune crons	
Principles	2
perating Principles	د.
Functional Diagram	
Output Relay Configuration Options	
Total Time Delay Calculation	
Voltage Measurement Time Curve	
Frequency Measurement Time CurveFigure 3	
System Software Description	
System Flow Chart	.9
Electrical Description	11
Ac Supply	11
Dc Supply	11
Block DiagramFigure 5	12
Power Loss Time DelayFigure 6	13
Capacitor Power Hold-Up Option	1 4
echanical	16
Mechanical ConfigurationFigure 7	
nstallation	18
Semiflush Mounting Screw	
Mounting & Outline Dimensions	
Hole Drill & Cutout DimensionsFigure 10	
Mounting Conversion	
Terminal Block Connections	
TEMBLIC DIUCK CONNECTIONS	<b>4</b> 1

	Output Contact Option	1
	External ConnectionsFigure 11	2
	Typical ConnectionsFigure 12	23
	Output Contact Option DiagramFigure 13	24
	Additional Output Contacts	24
Choos	ing Limit Settings	25
	Effect of Line Phase Shift on an Under/Over Frequency Relay	25
	Under and Overvoltage Settings	25
	Timers	
	Function Enable	25
	Minimum Under/Over Frequency Trip Timer SettingsFigure 14	26
Field	Adjustment	28
	Changing the Voltage Setpoints	28
	Voltage Setpoints Resistor Values	29
	Mother BoardFigure 15	
	Changing the Frequency Setpoints and Timers	
Maint	enance	ŧ 1
	M-0315 PRIDE Test Adapter	
	Troubleshooting	
	Replacement Fuses	
	Location of Input Fuses & Output RelaysFigure 16	
	Functional Test Procedure	
	Self-Test Error Indicators	
	M-0297/M-0397 Field Adjustment Unit Installed in the M-0290	
	N-029//N 033/ Field Adjustment Offic Installed In the N 0230	, 0
Docia	n Changes	20
resign	ii Ciidliyes	, 9
Wares	nty and Indomnification	41
marral	nty and Indemnification	*T

In our efforts to provide accurate and informative technical literature, suggestions to improve the clarity or to correct errors will receive immediate attention. Please contact the Administrative Services Department, specifying the publication and page number.

#### INTRODUCTION

#### THE NEED

Since the enactment of the National Energy Act of 1979 a large number of small private energy producers have been planning and building small generation facilities in order to sell power to the local utility. Electric utilities across the country have been planning for interconnection of these small generators, and have been working on solutions to the associated problems that interconnection creates. Previously, the privately-owned sources of generation were typically large industrial plants with multi-megawatt generators connected to the power system at a substation through a dedicated line. Many of the new smaller sites (less than about 3 MW) are connected directly to the closest distribution circuit. With this configuration, the parallel generator may now energize a distribution line after the substation breaker or line recloser has opened. In some cases the small generator could support the load and operate as an isolated system.

Utility specifications for the safe interconnection of these small generators generally require voltage and frequency relays that can detect when a line is isolated from the system. The PRIDE Unit was designed to provide a multifunction relay in one package that would supply the voltage and frequency relaying required to prevent dangerous excursions in voltage or frequency.

In addition, the high-speed operation and processing power make the microprocessor-based PRIDE Relay ideally suited for more complex programming of other protective relay functions. The PRIDE Unit, therefore, is applicable as a general purpose, multifunction protective relay.

#### BACKGROUND

A survey was conducted of the two hundred largest utilities and of the IEEE Dispersed Storage and Generation (DSG) Working Group concerning utility relaying policies relating to interconnection of parallel generation. Upon completion of this survey, a second, more specific survey was taken of those who responded to the first survey. The second survey included a preliminary specification for a relay intended to satisfy many of the interconnection relaying requirements for small dispersed generators to the utility grid. The results of the two surveys were formulated into a design specification for a multifunction relay that would satisfy many of the DSG relaying requirements that appeared to be common among the various interconnection schemes and that would also be suitable as a general purpose protective relay, with a different program and minor hardware changes, if required.

Through our research, the need for a single-phase and a three-phase relay became apparent. The single-phase relay needed to be low-cost due to the economics of small single-phase installations. Several compromises in functional flexibility were made in the single-phase design to meet the cost goals. The three-phase relay was designed to obtain as much flexibility in application as possible.

This manual describes the Single Phase M-0290 PRIDE Voltage & Frequency Relay only. A separate manual gives a complete description of the Three-Phase M-0296 PRIDE Voltage & Frequency Relay.

# **APPLICATION**

#### RELAYING PUNCTIONS

The main relaying functions chosen for the PRIDE Unit are targeted at the problem of detecting an abnormal condition on the distribution circuit, as evidence of isolation, and then tripping the small generator. However, the flexibility of the PRIDE has been increased as additional features were added. The M-0290 can now be used in a variety of applications where a multi-function voltage and frequency relay is needed. The relaying provided is listed in Table 1. Refer to the SPECIFICATIONS for a complete description of the adjustment ranges and of the accuracy of each of the relaying functions.

FUNCTION	DEVICE NUMBER	M-0290 SINGLE-PHASE
Undervoltage	27	х
Overvoltage	59	х
Under Frequency	81U	х
Over Frequency	810	х
Undervoltage Trip Timer	2UV	x
Overvoltage Trip Timer	20V	x
Under Frequency Trip Timer	2UF	x
Over Frequency Trip Timer	20F	X
Reconnect Timer	2Reclose	x

TABLE 1 Relaying Functions

# **OPERATING PRINCIPLES**

#### FUNCTIONAL DESCRIPTION

In order to understand the operation of the microprocessor-based relay, refer to the Functional Diagram shown in Figure 1. This diagram indicates the mix of hardware and software and represents the software in a logical form, but does not represent the actual mechanization of the relays or the flow of the program. However, it is useful in understanding how the various relaying functions are combined, the hardware/software mix, and the overall operation of the unit.

The M-0290 uses a low-cost Ac/Dc converter and analog level detectors for the over and undervoltage detection. This provides an economical design at the expense of accuracy and flexibility in changing the Over and Undervoltage setpoints. The single-phase Over and Undervoltage setpoints are determined by precision resistors in the over and undervoltage circuits. These resistors can be changed by the user if settings other than those ordered are desired. See Table 2 under the FIELD ADJUSTMENT section. The over and under frequency relaying and the time delays are implemented in the microprocessor software. The limit settings for the software functions are stored in the processor memory. In order to change these settings, the memory circuit board can be exchanged or the settings can be altered by the customer using the optional Field Adjustment Unit M-0297/M-0397. Refer to the FIELD ADJUSTMENT section for a complete description of this procedure.

The frequency calculations require reliable reproduction of the period of the input ac potentials. Input Loss detection is used to determine if sufficient potential or sensing input voltage is available for a reliable measurement of frequency.

Two types of Input Loss Detection are incorporated in the software of the PRIDE Units.

- 1. Any frequency measurement above 80 Hz and below 40 Hz will be ignored. This is the Frequency Blocked State and will be indicated by both frequency LEDs turning on.
- 2. If no zero-crossings are detected for approximately 0.5 sec or if the voltage falls below 0.45 p.u., the frequency measurement will also be blocked; therefore, frequency cannot initiate tripping. The reason for this implementation is to allow the undervoltage condition to trip the relay.

If the voltage input is lost or if a "noisy" loss occurs and the Under Frequency Trip Timer is set extremely low (1 to 3 cycles), there may be a chance that the Under Frequency Trip Timer may time out before the loss can be detected and the frequency timers can be blocked. Refer to the section on CHOOSING LIMIT SETTINGS for recommended Trip Timer settings.

The frequency will also be blocked if the <u>rate</u> of change of frequency ( $\Delta F$ ) is greater than 1 Hz/cycle in successive period measurements. This  $\Delta F$  Transient Protection will prevent noise spikes from triggering the frequency timers.

The frequency functions use a counter in the microprocessor to determine the period of the input. The period is calculated after each cycle. A digital filter in the processor software filters the period data to reduce the effect of phase jitter on the measurement. The filtered period data is then compared to the upper and lower limits stored in the processor memory. Since the period is the reciprocal of frequency, the Over/Under Frequency function is accomplished.

Dynamic hysteresis is incorporated in the frequency measurement routine. While the trip point always remains absolute, the point where the frequency returns within the setpoint range will vary as follows:

$$F_r = \frac{F_S}{F_S (.002083) + 0.875}$$
 (1)

Where: F<sub>s</sub> = Over or Under Frequency setpoint (Hz)

 $F_r$  = Frequency return point (Hz)

FIGURE 1 Functional Diagram

Therefore, the farther the setpoint is from 60 Hz, the greater the hysteresis.

The time delays for tripping and reclosing use an internal crystal oscillator as a clock. The time delays in Figure 1 provide a delay only on an input transition from a logic low to a logic high. No delay is incorporated from a logic high to a logic low. The voltage and frequency time delays are used to delay tripping, ensuring that a transient condition will not cause an unnecessary trip. The Reconnect Timer can be programmed for up to 1092 seconds to ensure the system is stable and reclosers have all completed their sequences before reconnection.

#### **QUIPUT RELAY CONFIGURATION OPTIONS**

As stated in the SPECIFICATIONS and shown in Figure 1, one of the following three output relay configurations is possible.

The Standard Relay Configuration (Position 1) will be used in most CSG applications where any power loss or Self-Test error will cause the relay to de-energize. This is defined as the Tripped state in this configuration.

The Alternate Relay Configuration (Position 2) will be used in larger power plant applications, where a Self-Test error or power loss to the unit will not cause the PRIDE® to trip the generator off-line. When in the Alternate Relay Configuration, the output relay will energize when the Trip condition is met (i.e., when a Trip Timer times out, the Trip output relay will energize). Self-Test errors or power loss will de-energize the output relay, defined as the Close state.

The Pulse Relay Configuration (Position 3) is logically the same as the Alternate Relay Configuration, except the output relay will only energize for 0.5 sec when the Trip condition is met. This option will be used in circuit breaker applications where the trip signal will be momentary.

NOTE: It is important to remember that the three Output Relay Configuration options are separate from the the Output Contact option which is chosen as normally open or normally closed.

#### TOTAL TIME DELAY CALCULATION

The total time delay for the PRIDE Unit to trip or close is composed of two independent components.

- 1. The time delays specified in the Over/Undervoltage Trip Timers, Over/Under Frequency Trip Timers and Reconnect Timer.
- 2. The measurement time delay for the internal circuitry to detect the change in the input condition.

The measurement time must be added to the time delay specified for the Over/Undervoltage Trip Timers, Over/Under Frequency Trip Timers and Reconnect Timer.

The measurement time can be determined using the LED indicators on the front panel. The measurement time is defined as the time between the change in the input condition (i.e., the voltage or frequency shift) and the front panel LED turning "ON" (or alternately turning "OFF" for an input condition shifting into range).

The intentional time delay programmed in the Trip Timers or the Reconnect Timer can be determined by measuring the time delay between when the LED changes state and when the relay contacts change state. This time includes a minimum time of 1 cycle for the output relay to operate.

A technique to determine a close estimation of what the measurement time delay will be for various input conditions is described in the following sections.

#### VOLTAGE MEASUREMENT TIME

The time required for the M-0290 to detect an over or undervoltage condition is dependent on the voltage level before and after the voltage change and the setpoint of the over/undervoltage detector. In case the potential input drops to zero volts from its nominal 100% value, the following time delays for measurement can be expected.

U <b>nder</b> voltage Setting	Measurement Time Delay (Maximum)
5%	3 cycles
10%	4 cycles
20%	6 cycles

Longer measurement delays can be expected if the input change is less. For example, if the input voltage drops from 100% to 75% and the undervoltage setting is 80%, a measurement delay of 20 cycles can be expected.

The measurement time delay for either under or overvoltage can be calculated from Figure 2. This figure can be used for either an increase or decrease in the input voltage if the voltage setpoint is between the initial voltage and the final voltage.

The following two examples are shown to clarify this technique. Refer to Figure 2 for definitions of the terms.

#### Example 1.

$$\frac{\text{Vset}}{\text{Vstep}} = \frac{(130 - 120)}{\text{X } 100\%} = \frac{10}{\text{X } 100\%} = 50\%$$

$$\text{Vstep} \quad (140 - 120) \quad 20$$

$$\text{Time Delay (from Figure 2)} = 0.16 \text{ sec (9.6 cycles)}$$

#### Example 2.

$$\frac{\text{Vset}}{\text{Vstep}} = \frac{(120 - 108)}{\text{X } 100\%} \times 100\% = \frac{12}{\text{X } 100\%} = 60\%$$

$$\text{Vstep} \quad (120 - 100) \qquad 20$$

$$\text{Time Delay (from Figure 2)} = 0.19 \text{ sec (11.4 cycles)}$$

#### PREQUENCY MEASUREMENT TIME

The time required for the M-0290 to detect an over or under frequency condition is dependent on the frequency before and after an input frequency step change and the setpoint for the Over/Under Frequency detector. The frequency is measured each cycle of the potential input. A digital filter is used in the microprocessor to filter the data. This filter can add time delay dependent on how the input changes relative to the setpoint. Figure 3 shows how the filter output changes for a step change in input frequency. If the setpoint is 62 Hz, the measured delay time is 1 cycle. However, if the setpoint is 64.5 Hz, the delay time is 4 cycles.

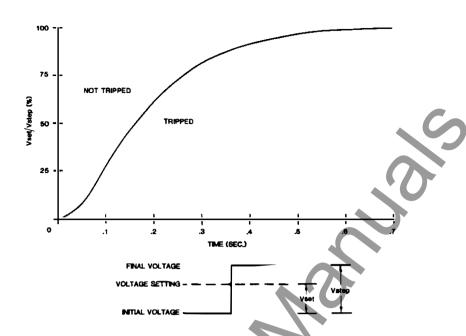


FIGURE 2 Voltage Measurement Time Curve

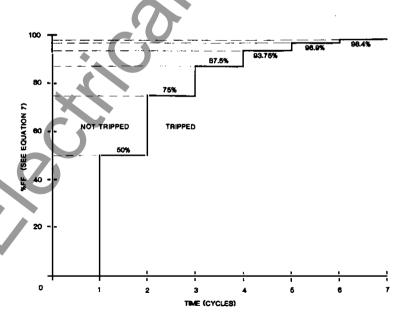


FIGURE 3 Frequency Measurement Time Curve

Using the vertical scale of Figure 3 (labeled "% FF"), the measurement time delay for any frequency step change can be determined. Negative frequency step changes are treated the same as positive changes.

A step change from 60 Hz to 55 Hz with an Under Frequency setting of 58 Hz would be detected in the next cycle after the change.

The digital filter is implemented as follows:

$$F_{(nt)} = \frac{F_{(n-1)t} + F_{s(nt)}}{2}$$
 (5)

Where: F(nt) = Filter output at time nt

F(n-1)t = Filter output at time (n-1)t

FS(nt) = Latest frequency sample at time nt

NOTE: On newer units with  $\Delta F$  Transient Protection, one extra cycle will be added to the above delays.

#### SYSTEM SOFTWARE DESCRIPTION

NOTE: There are a number of words used by the power industry and by the computer industry that appear to be similar but, in fact, have very different meanings. The following section refers to the definitions used by the computer industry.

Refer to the System Flow Chart shown in Figure 4. The PRIDE software runs under a "mini" real-time operating system. The operating system is divided into three main parts: The Interrupt Handlers, the Process Controller, and the Kernel.

#### INTERRUPT HANDLERS

The Interrupt Handlers are small routines to service the incoming interrupts. Each interrupt routine will schedule, through the operating system, its appropriate control task (i.e. the zero-crossing interrupt will schedule the frequency measurement task).

#### PROCESS CONTROLLER

The Controller's main purpose is to process data passed to it from the interrupt handlers or from other tasks. The controller can be broken down into four tasks.

- 1. Relay control
- 2. Input conditioning and processing
- 3. Timers and counters
- 4. Self-Tests

These tasks each have a priority assigned to them by the operating system according to their importance to overall system flow.

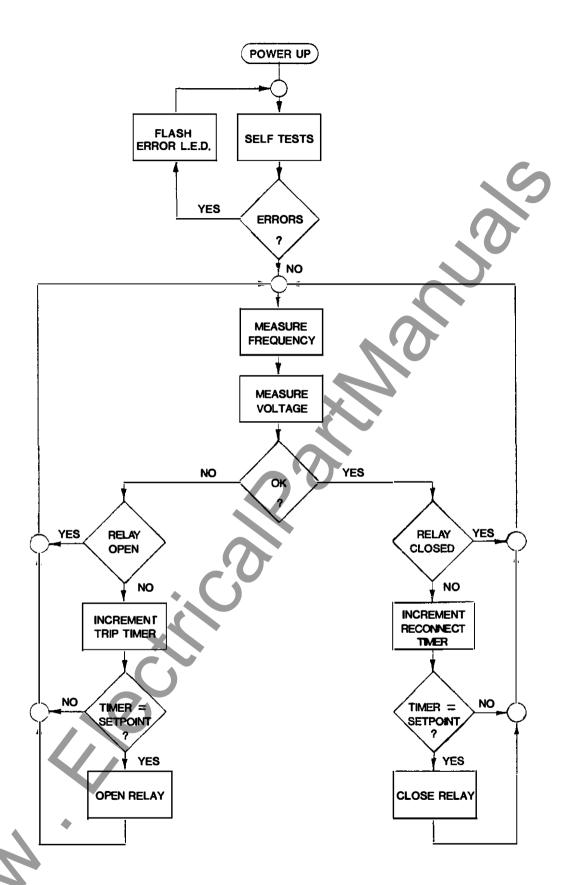


FIGURE 4 System Flow Chart

#### Relay Control

The Relay Control controls the state of the output relay.

#### Input Conditioning and Processing

This process is the largest and most complicated of those listed. The actual correlation and computation of input data and the decisions on whether a given measurement is within the setpoint range is accomplished here. This capability for high-speed processing and ability to dynamically change the weight of input conditions is one justification for the incorporation of the microprocessor.

#### Timers and Counters

This process increments the various timers for voltage, frequency and reconnect, and makes the time-out decisions based on setpoint values,

#### Self-Tests

On Power Up, the M-0290 will run through a series of Self-Tests to determine if the hardware and software will function properly when brought on-line.

The M-0290 will also perform tests on a low priority basis in its idle time. If no other tasks are pending, the Self-Test task will continuously run. Failures of any of these tests will result in the output relay de-energizing. A front panel LED will flash indicating an error condition. The Self-Test errors will be described in more detail in the MAINTENANCE section.

#### KERNEL

The nucleus of the operating system is the Kernel. The Kernel is composed of two parts:

- 1. The Scheduler
- 2. The Dispatcher

#### Scheduler

The Scheduler is flagged from an interrupt driver that is waiting for a task to be performed. Status bits are set by the scheduler to indicate that a task is pending, and then control is returned to the running task. Each task, when started, will run until completion except the Self-Test task which can be unconditionally preempted.

#### Dispatcher

When a task is completed, control returns to the Dispatcher where it picks up a vector to the pending task with the highest priority.

The Self-Test task is the lowest priority and is also permanently pending. Therefore, if the system is not busy, the M-0290 is constantly checking itself.

Because each task is scheduled on a cycle by cycle basis, the operating system can be considered to be operating in real-time.

CAUTION: Do not swap the M-0298 Memory Board or the M-0397 EE PROM Board between PRIDE models with suffix "A" and "B" and those with suffix "C" (i.e., between M-0290B and M-0290C), since this will cause them to misoperate. Refer to the DESIGN CHANGES section of this manual for an explanation of the differences.

#### ELECTRICAL DESCRIPTION

The Block Diagram for the M-0290 is shown in Figure 5. The following discussion describes the basic operation of the circuitry.

#### INPUTS

Power is applied to the PRIDE®via rear terminals TB1-3 and TB1-4. The PRIDE can be powered from either ac or dc sources as described below. The Sensing input (TB1-5 and TB1-6) is used only for measurement purposes and draws only a small burden. However, in many cases, the ac power input will be connected to the Sensing input, due to the lack of a separate ac power source.

#### Ac Supply

The Ac Supply PRIDE Units operate from a 120 V ac source. If this is unavailable, the Dc Supply, described below, may be ordered for the PRIDE.

#### Dc Supply

The Dc Supply mounts in the bottom compartment of the PRIDE (see Figures 7 and 16). Three nominal dc voltage options are available: 125 V dc, 48 V dc or 24 V dc. The PRIDE will operate from approximately 65% of the nominal voltage to 128% of the nominal voltage (i.e., 80 to 160 V dc for the 125 V dc option). Operation from 250 V dc is possible, but requires an M-0319 external Dropping Regulator to provide 125 V dc nominal input voltage to the PRIDE. The M-0290 should be ordered for 125 V dc operation and the M-0319 is ordered separately. The M-0319 is a resistor-zener diode regulating device used to produce 125 V dc power from a 250 V dc battery source.

#### POWER SUPPLY

The Power Supply provides the voltages necessary for operation of the digital and analog circuits. A Power Loss Detector is incorporated to warn if the the power supply fails. The Power Loss Detector feature is described in detail below.

#### Power Loss Detector

When the power supply fails, the input power is lost, or if the input power fuse blows, the Power Loss Detector will:

- 1. Reset the microprocessor.
- 2. De-energize the Kl output relay (this will be the Trip State in the Standard Relay Configuration and the Close State in the Alternate or Pulse Relay Configuration).
- 3. Turn off the front panel POWER OK LED.
- 4. De-energize the normally closed K4 Power Loss relay. This contact can be used to sound or light an alarm.

The time delay between when the Power Loss Detector senses a loss and when the Kl output relay is deenergized is shown in Figure 6. The data was taken by connecting the power input to the Phase A input of the PRIDE Three-Phase M-0296. A similar curve can be expected with data taken for the M-0290. The Phase A input was dropped from 120 V ac to levels per the graph, and the time delay for tripping was measured. When the input dropped below approximately 75 V ac, the PRIDE trip time dropped to 0.25 sec. This is the level where the internal power supply voltage is below its minimum operating level and the Power Loss Detector resets the PRIDE. Therefore, if the input power drops to this level, the PRIDE may trip faster than the programmed time (3 sec in this case).

If this feature is not desirable, the Capacitor Power Hold-Up Option, described below, is available for the PRIDE.

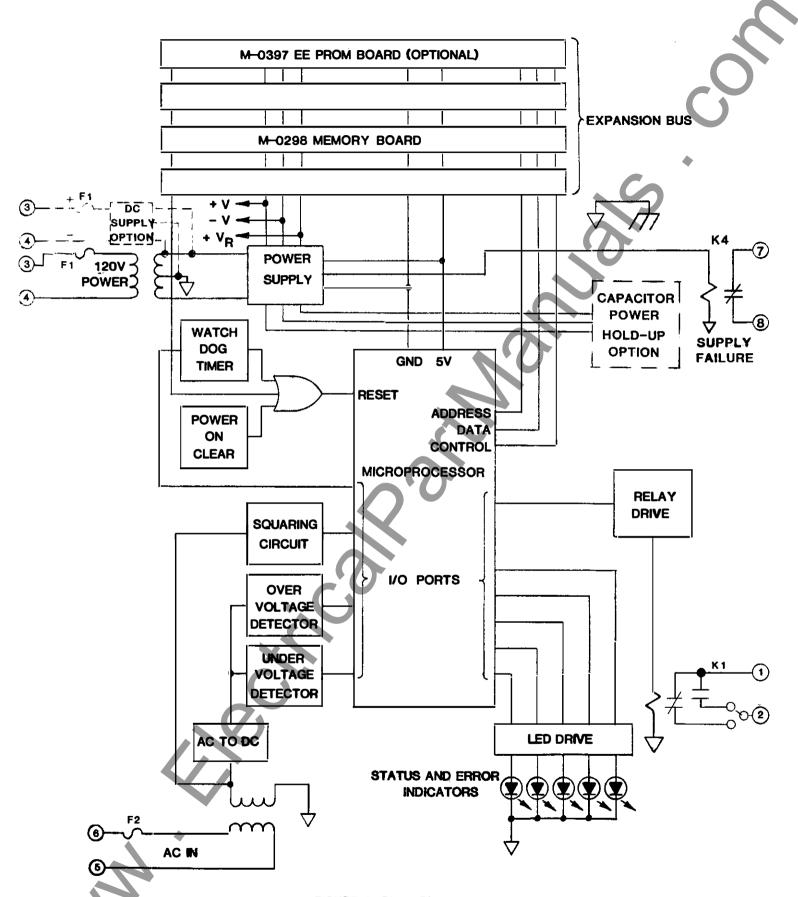
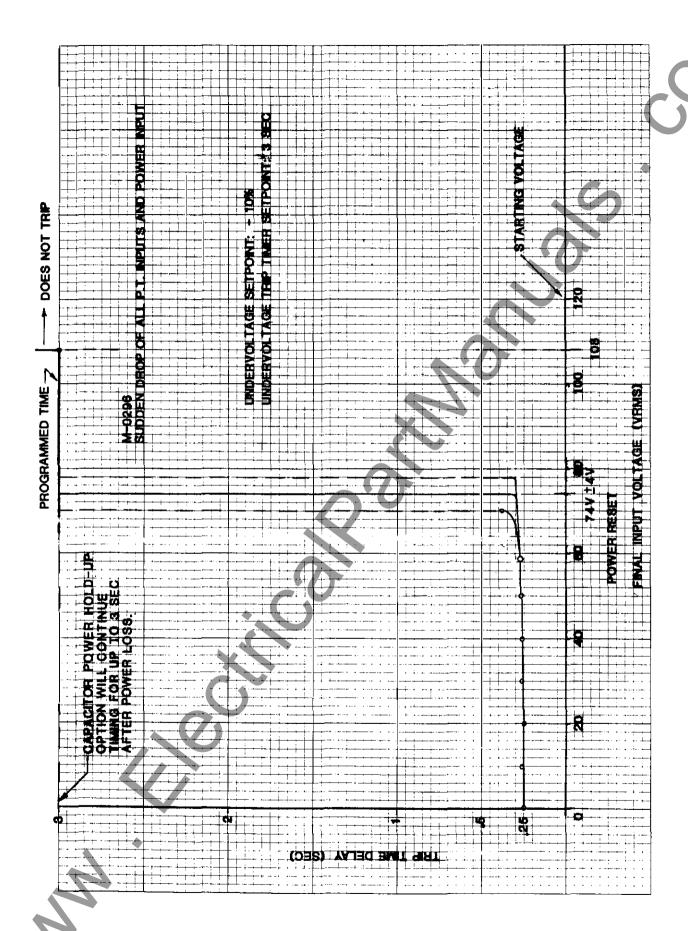


FIGURE 5 Block Diagram



#### CAPACITOR POWER HOLD-UP OPTION (Ac Supply PRIDE®Only)

The PRIDE is designed to operate over a wide range of power supply voltages and wave shapes. The Capacitor Power Hold-Up Option is available if an Ac Supply PRIDE is required to ride through (no tripping) a loss of input power for up to 3 sec. The circuit board, that mounts in the bottom compartment of the PRIDE, provides energy storage so that the PRIDE Unit can continue to operate for up to 3 sec even if the input power source fails. In cases where delayed tripping is required, the PRIDE will time out and delay tripping for up to 3 sec maximum.

CAUTION: If the M-0297/M-0397 Field Adjustment Unit is mounted in the PRIDE, the power switch on the M-0297 PRIDE Control Unit should be kept in the OFF position unless the Field Adjustment Unit is in use. With the M-0297 power switch in the ON position, the unit will not operate for three seconds after a power interruption.

#### WATCHDOG TIMER

The Watchdog Timer performs the function of overlooking the program flow of the microprocessor. The watchdog will reset the microprocessor back to an orderly start-up sequence if the program flow is upset or if the software does not perform an operation within the allotted time period. The microprocessor will periodically update or "refresh" the watchdog to keep it out of a reset condition.

#### POWER ON CLEAR

The Power On Clear block is an RC circuit which insures that a proper Power Up sequence has been accomplished when power is first applied to the unit.

#### SQUARING CIRCUIT

The Squaring Circuit converts the sinusoidal inputs to square waves. The microprocessor can use these inputs to determine the period (and thus frequency) of the ac input.

#### OVERVOLTAGE DETECTOR

Based on properly chosen component values, the Overvoltage Detector will trip, signaling the microprocessor of an overvoltage condition.

#### UNDERVOLTAGE DETECTOR

The Undervoltage Detector works in the same manner as the overvoltage detector, signaling the microprocessor of an undervoltage condition.

#### AC to DC

This block converts the sine wave inputs to a dc value proportional to the amplitude of the sinusoidal input.

#### LED and RELAY DRIVE

Because of the microprocessor's low current-sourcing capability, added drive is needed for powering the LED indicators and relays.

#### STATUS and ERROR INDICATORS

All LEDs will remain off when conditions are within specified limits and will light when an over or under limit condition occurs. In addition, the PRIDE Unit has a self-checking feature that will indicate errors by flashing the LEDs. The Self-Test feature will automatically reset and re-test to assure that the error condition is still present. Refer to the MAINTENANCE section for further details.

#### MICROPROCESSOR and ROM

The microprocessor gathers all the external inputs, calculates and processes the data, drives the status indicators and energizes the relays. The microprocessor contains various on-chip functions for frequency measurement and time delay synchronization.

The ROM (Read Only Memory) Memory Board M-0298 contains the program for the microprocessor. The ROM also stores the setpoints programmed at the time of manufacture. The Field Adjustment Unit M-0297/M-0397 can be added to allow programming all but the Over and Undervoltage setpoints. Refer to the FIELD ADJUSTMENT section for further details.

CAUTION: The ROM is of the ultraviolet erasable type and can be erased if the protective tab is removed from the window and the window is exposed to ultraviolet light.

#### **EXPANSION BUS**

All PRIDE Units contain an Expansion Bus for future options. Expansion cards can be plugged into the bus to add new capabilities. Software changes can be accomplished by changing or adding a new M-0298 ROM Memory Board via the Expansion Bus.

# **MECHANICAL**

The PRIDE packaging was designed for the maximum protection of the electronic components from the electrical and natural environment. The steel box is compartmentalized as shown in Figure 7. The inputs and outputs enter the unit at the bottom in a Power Input compartment where the output relays and transformers are mounted. This compartment contains no components that are sensitive to voltage transients or electromagnetic interference (EMI).

The transient suppression required to meet the ANSI Surge Withstand Capability and Fast Transient Test is also located in the Power Input section. The power and potential transformers in this compartment convert the 120 V ac inputs to the lower levels used by the PRIDE. The signals from the imput section pass through EMI filters in an internal bulkhead before entering the Power Supply and Processor/Logic section.

The EMI filters serve a dual purpose. The external interference on the power and potential inputs is prevented from entering the sensitive circuit area. Also, the inherent noise generated by the microprocessor and switching regulator is prevented from leaving the relay and interfering with other equipment.

**CAUTION:** Do not apply any form of test equipment to circuits within the protected portion of the box. In changing any cards within this box, remove all external voltages. Keep one hand on the case to discharge static electricity before touching any of the cards.

#### TEST BLOCKS

Most utilities have standardized on one of many different test blocks, G.E., Westinghouse and States being the most common. Therefore, Beckwith Electric has not supplied a test block on the PRIDE Unit, thus enabling the user to incorporate his standard test block. This must be added external to the PRIDE Unit.

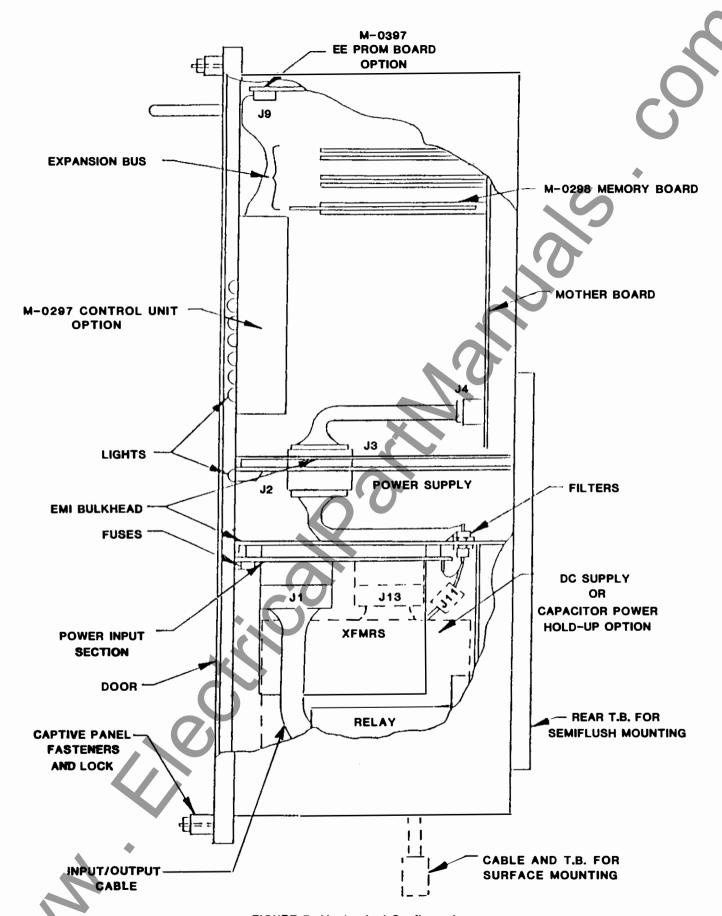


FIGURE 7 Mechanical Configuration

# **INSTALLATION**

CAUTION: Before installing, verify that the settings required for the various functions are correct by checking the settings sticker mounted on the inside surface of the unit.

The PRIDE\*Unit can be surface mounted or semiflush mounted as shown in Figures 9 and 10. Many small generator applications will use a weather-proof box containing the PRIDE, manual disconnect and a contactor for the interconnection relaying. In these systems the relay will be surface mounted. Other systems will require semiflush mounting using a rectangular cutout in a relaying panel or swinging door. Refer to Figure 9 for mounting and outline dimensions and Figure 10 for hole drill and cutout dimensions for semiflush mounting.

Because the semiflush mounting nut is located on the inside lip of the relay box and under the front cover, care should be taken when choosing a mounting screw. These should be #10-32 screws; four are required. Refer to Figure 8 for choosing the length of the mounting screws for semiflush mounting. The length of the screw should not exceed 1/4" from the back side of the mounting lip. The total length should be 1/4" plus the thickness of the panel.

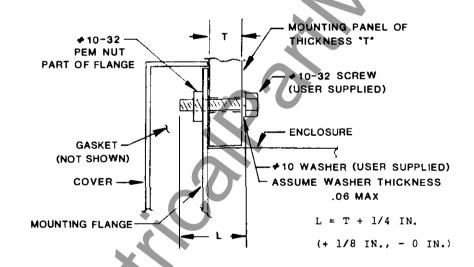


FIGURE 8 Semiflush Mounting Screw

The external wiring connections to the PRIDE Unit are made to a 12-position terminal block that is mounted on the rear of the PRIDE when a semiflush mount unit is ordered. If a surface mounted PRIDE is ordered, a 6-inch cable will extend below the unit with the terminal block attached. The terminal block should then be connected to the panel to which the PRIDE Unit is mounted. Both terminal block positions are shown in Figure 9.

A lug is located in the lower left hand corner for case grounding purposes. Number 6 to 14 AWG wire can be used for this ground strap.

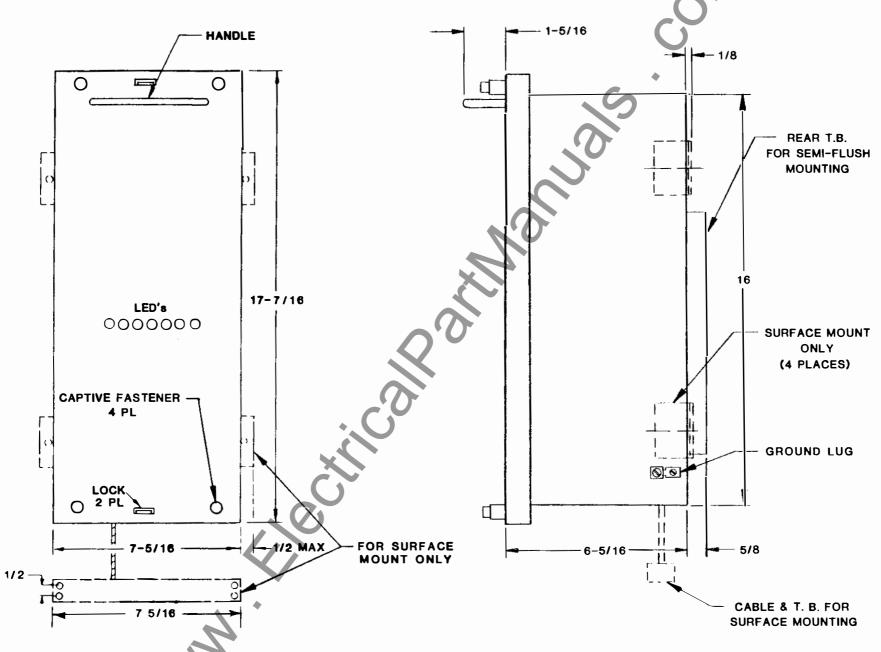


FIGURE 9 Mounting & Outline Dimensions

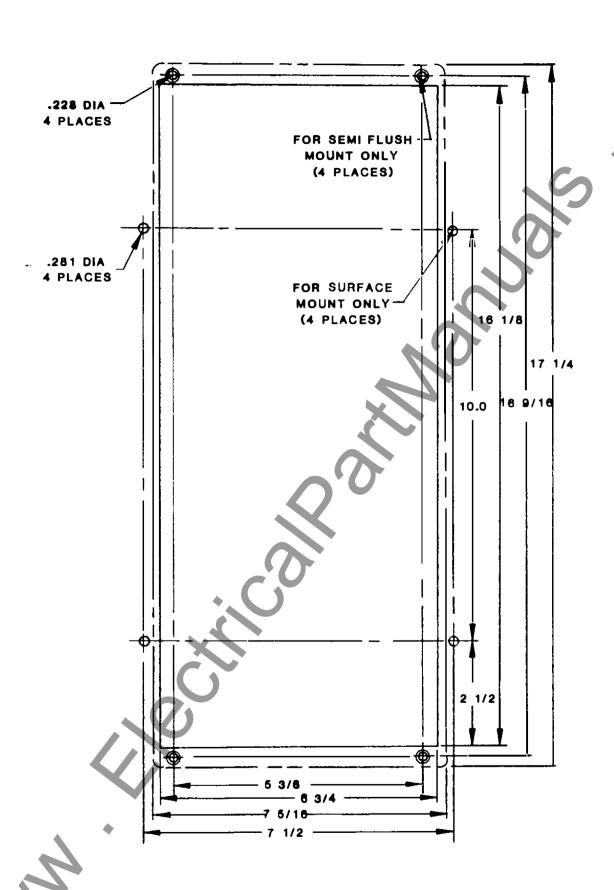


FIGURE 10 Hole Drill & Cutout Dimensions

#### MOUNTING CONVERSION

Conversion of a PRIDE\*Unit from surface to semiflush mounting or vice—versa can be accomplished by the following procedure.

- 1. Conversion must be done with all external connections to the terminal block removed.
- 2. Disconnect connector J1 shown in Figure 7 from the Power Input assembly.
- 3. Remove the input cable from the cable clamp located on the left side wall of the lower compartment. This clamp is not used when the Dc Supply is installed.
- 4. Remove all wires from the terminal block.
- Carefully pull the wires through the plastic hole plug and remove the cable harness, with the Jl connector, from the unit.
- 6. Switch the two plastic hole plugs so that the solid plug covers the hole that is not to be used for the external cable. The hole plug used for the cable feed-through should be mounted as follows.

Semiflush: Mount the feed-through plug in the hole at the rear of the unit.

Surface: Mount the feed-through plug in the hole on the bottom left side of the unit.

- 7. Carefully push the wiring harness (TB1 end) through the feed-through hole plug from the inside of the PRIDE enclosure. (J1 connector will then be inside the lower compartment.)
- Re-attach the harness to the cable clamp on the inside of the lower compartment (Ac Supply PRIDE only).
- 9. Reconnect the harness terminals to the terminal block, being careful to maintain the sequence of wires from 1 to 12.
- 10. For semiflush mounting, the cable and terminal board should be hanging from the rear of the PRIDE. Mount the terminal board to the four holes on the rear using the four screws and nuts supplied with the unit. Pull all excess cable inside the enclosure and secure with the cable clamp.
- 11. For surface mounting, mount the terminal block at any convenient location on the mounting surface.
- 12. Reconnect Jl to the Power Input assembly.

#### TERMINAL BLOCK CONNECTIONS

The external connections for the M-0290 Single-Phase PRIDE are shown in Figure 11. Figure 12 shows a typical connection for the potential inputs of the M-0290.

#### OUTPUT CONTACT OPTION

The PRIDE Relay uses a commercially available SPDT relay for the Trip and Close functions. The relay output contact is a type "C" arrangement. One side of the "C" contact is wired to the external terminal block. The relay configuration relative to the octal socket is shown in Figure 13. The normally open contact or the normally closed contact can be wired to the external terminal block. One large blue wire is connected to either terminal 3 or 6 on the bottom of the relay socket. A normally closed output contact is achieved by connecting the wire to terminal 3. A normally open output contact is achieved by connecting the wire to terminal 6. This change can be easily accomplished in the field by switching the wire on terminals 3 or 6.

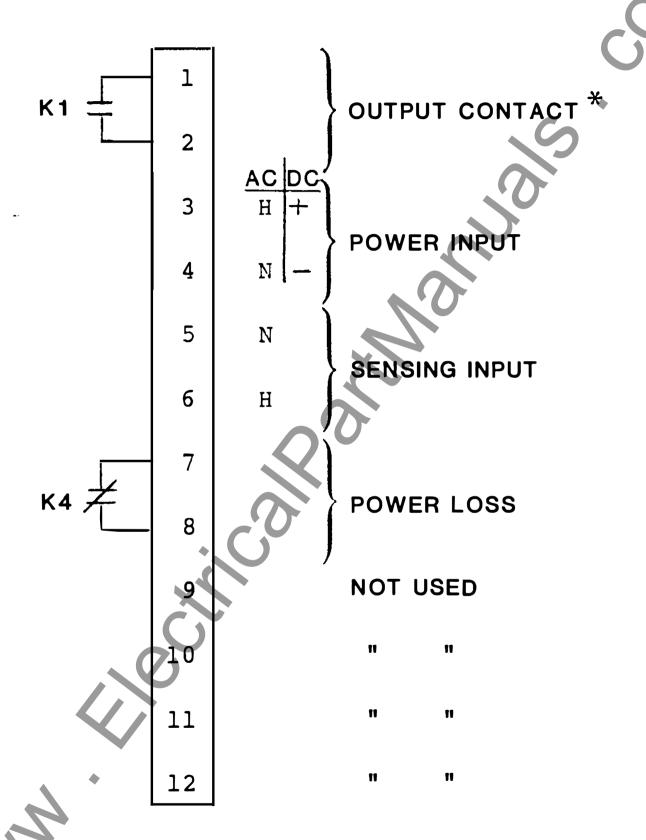


FIGURE 11 External Connections

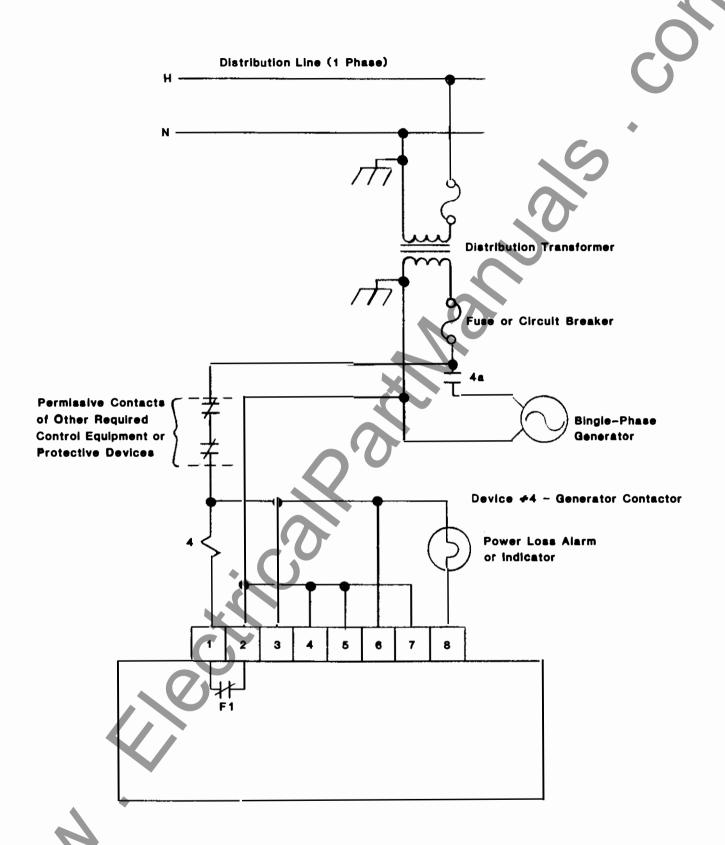


FIGURE 12 M-0290 Connection to Small Single-Phase Generator Contactor

- CAUTION: Before changing the relay contacts or modifying the wiring, all external power must be removed from the PRIDE Unit. Connector Jl can be used to disconnect the external terminal block only if the current in the output contacts is either externally disconnected or is not flowing through an inductive load that would cause arcing in the Jl connector when the output circuit is opened.
- NOTE: When Jl is disconnected, the PRIDE output contact is in an open-circuited condition.

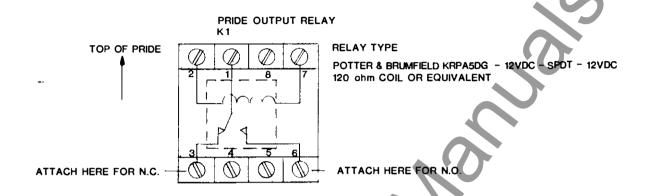


FIGURE 13 Output Contact Option Diagram

# ADDITIONAL OUTPUT CONTACTS

Additional output contacts for the PRIDE Unit may be added by changing from an SPDT to a DPDT octal socket relay (i.e. Potter & Brumfield KRPllADG-12VDC) Beckwith Electric Part # 43160. The contact ratings for the additional contact are the same as those given for the normal output contacts. Connections to the relay socket for the normal output contact must be changed from relay socket terminal 3 to terminal 4 for the normally closed contact. Relay socket terminal 3 is used for the normally open output contact. The additional contacts can be accessed at the relay socket terminals:

Additional Contact Terminal Number

1 - common	8 - common
4 - n.c.	5 - n.c.
3 - n.o.	6 - n.o.

Normal Contact

CAUTION: The wires connecting to the second contact should be routed through the rear or side wiring access hole. External connections to this additional "C" contact must be made directly to the relay socket, bypassing connector J1. These connections are not disconnected when J1 is unplugged.

# CHOOSING LIMIT SETTINGS

When the PRIDE®Unit is purchased, the user should specify the desired limit settings. These settings will be stored in the ROM (Read Only Memory) on the M-0298 Memory Board before the relay is shipped to the user. A record of the settings and serial numbers of the boards will be kept on file by Beckwith Electric. Before installing, assure that the settings listed on the label match those ordered. In many cases there will never be a need to change the settings; however if a change is desired, any of the options listed under the FIEID ADJUSTMENT section may be employed. In choosing the settings desired, the following factors must be taken into consideration.

#### EFFECT OF LINE PHASE SHIFT ON AN UNDER/OVER PREQUENCY RELAY

Due to variations in the load flow on a line, the phase angle at any point on the line will shift relative to the phase at the substation bus. The transient effect observed on the line at any load point will be a variation in the period of the ac voltage in the cycle during which the loading changes. A frequency relay that is measuring the period of the power line potential will detect the variation in the period and may indicate an over or under frequency condition.

The PRIDE uses a unique digital filter to eliminate the effect of line phase shift. The PRIDE measures the period of each power line cycle and uses the digital filter (Equation 5) to smooth the data before determining if the frequency is within the M-0290 setpoints. The digital filter will produce a transient output for several cycles after a phase shift takes place. However, the Power Loss software will throw away a period that changes more than 273 us from the previously measured period. This corresponds to an apparent phase shift of 6°. A phase shift of less than 6° will cause a temporary response from the digital filter that could indicate an over or under frequency condition, if the over frequency or under frequency setpoint is within 1 Hz of 60 Hz. Therefore, the minimum time delay settings of Figure 14 are recommended for over frequency and under frequency settings close to 60 Hz.

# UNDER AND OVERVOLTAGE SETTINGS

The Overvoltage setpoint must be at least 3% higher than the Undervoltage setpoint, i.e., the minimum voltage bandwidth is 3% total.

#### TIMERS

It is not recommended that the Frequency Trip Timers be set less then 3 cycles or the Voltage Trip Timers set less then 15 cycles. This is to prevent short-time transient effects on the measured ac line from causing nuisance trips.

#### FUNCTION\_ENABLE

Incorporated in the PRIDE is the capability to enable or disable certain functions. This can be accomplished either at the time of purchase by ordering the functions desired, or by using the optional M-0297/M-0397 Field Adjustment Unit. Refer to the M-0297/M-0397 Field Adjustment Unit Instruction Book for further details on this unit.

The following list shows the PRIDE functions that can be ordered (or programmed if using the M-0297/M-0397) as either enabled or disabled.

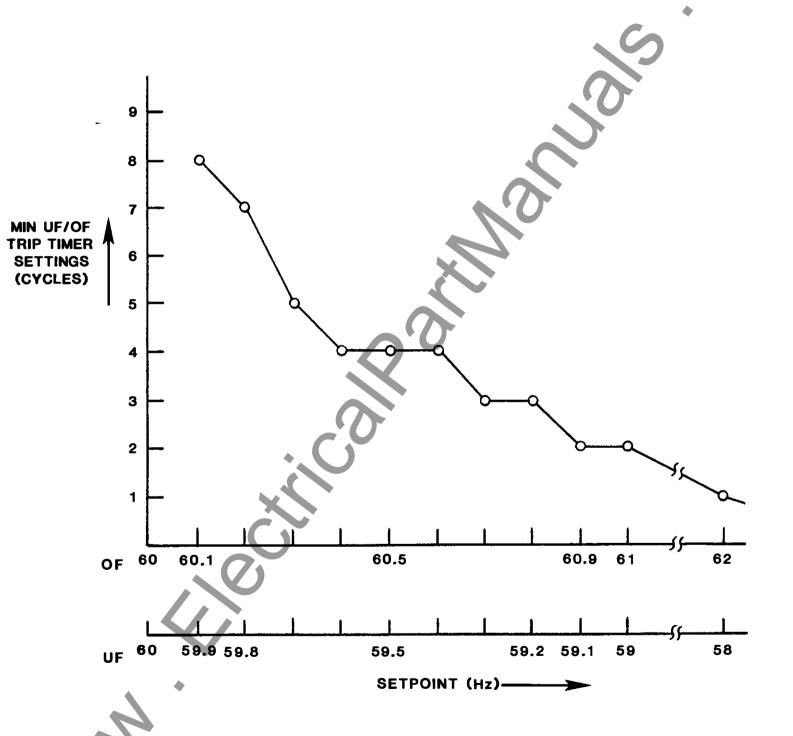


FIGURE 14 Minimum Under/Over Frequency Trip Timer Settings

# FREQUENCY MEASURBMENT

1. Over and Under Frequency

## VOLTAGE MEASUREMENT

1. Over and Undervoltage

# OUTPUT RELAY CONFIGURATION

- Standard Relay Configuration
   Alternate Relay Configuration
   Pulse Relay Configuration

# FIELD ADJUSTMENT

The user has several methods of changing the PRIDE® settings after the unit has been installed. These are described in the following sections.

#### CHANGING THE VOLTAGE SETPOINTS

#### USER MODIFICATION

The user can modify the undervoltage or overvoltage setpoint by changing the value of the resistors on the Mother Board that control the settings. Table 2 lists the setpoints and resistor value for each. The new resistors should be metal film, 1%, 1/8 W.

## Replacement Procedure

**CAUTION:** Power <u>must</u> be removed from the PRIDE before inserting or removing any boards. Be sure to discharge any static on the body or tools by touching the outer case before touching any of the printed circuit boards.

- 1. Disconnect the power to the PRIDE.
- 2. Remove the front cover.
- 3. Remove the side mounting rails and printed circuit board retainer.
- 4. Remove the Memory Board and place it on a static-free surface.
- 5. Remove connector J3 from the Power Supply section, and J4 from the Mother Board.
- 6. On PRIDEs with printed circuit board retainers on each corner of the Mother Board, use a small needle-nose pliers or flat screwdriver to squeeze the retainer tabs together, pulling the board out at each corner as you do so. On newer PRIDEs, remove the four retaining screws at each corner.
- 7. Remove the Mother Board by tilting it forward and around the four screw mounts on the case.
- 8. Resistor placement is shown in Figure 15. The Mother Board is coated with a moisture-resistant, conformal coating. Carefully scrape away the coating surrounding the resistor leads using a small, sharp knife, being careful not to damage the foil on the board.
- 9. Clip out the old resistor and discard.
- Remove the clipped wire using a Weller Controlled Output Soldering Station Model MTCPL, 60 W, 120
   V, 50/60 Hz or equivalent with grounded tip, and a solder sucking syringe or solder wick.

**CAUTION:** Do not attempt to melt the solder and push the new resistor through the hole as the leads are likely to catch the edge of the foil and lift it off the board.

# R21 UNDERVOLTAGE

R14 OVERVOLTAGE

VALUE	SETPOINT	VALUE	3	SETPOINT
4.12 K	-2%	178	Ω	+2%
3.65 K	-4%	698	Ω	+4%
3.40 K	-5%	976	Ω	+5%
3.16 K	-6%	1.24	K	+6%
2.26 K	-10%	2.37	K	+10%
1.18 K	-15%	3.83	K	+15%
174 Ω	-20%	5.49	ĸ	+20%

TABLE 2 Voltage Setpoints Resistor Values

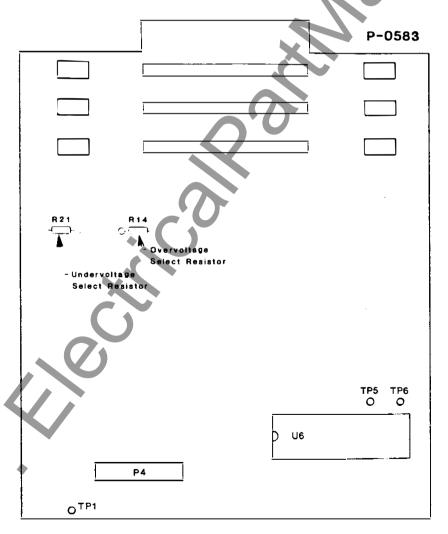


FIGURE 15 Mother Board

- 11. Carefully install the new resistor.
- 12. Replace the Mother Board by tilting it forward and behind the screw mounts.
- 13. If the PRIDE®has circuit board retainers, push the Mother Board back so that it snaps over the tabs, then pull forward to assure that it is firmly seated. On newer units, align the Mother Board and insert the four retaining screws.
- 14. Plug connector J3 into the Power Supply section and J4 into the Mother Board. The cable is symmetrical and can be plugged in either way.
- 15. Replace the M-0298 Memory Board into the middle slot of the Expansion Bus.
- 16. Attach the printed circuit board retainer and side mounting rails using the screws provided. The foam side of the retainer should be toward the boards.
- 17. Make a note of the new setting on the label inside the unit and on the SETPOINTS page of the M-0290 Instruction Book. Replace the front cover.

#### FACTORY MODIFICATION

The user can return the PRIDE to the factory for the above modification. The new setpoint values should be included on the purchase order at the time of return.

## CHANGING THE FREQUENCY SETPOINTS AND TIMERS

#### EXCHANGE OF THE M-0298 MEMORY BOARD

CAUTION: Be sure to remove all external voltages before changing the boards. Keep one hand on the case to discharge static electricity before touching any of the boards. Do not swap the M-0298 Memory Board or the M-0397 EE PROM Board between PRIDE models with suffix "A" and "B" and those with suffix "C" (i.e., between M-0290B and M-0290C), since this will cause them to misoperate. Refer to the DESIGN CHANGES section of this manual for an explanation of the differences.

When ordering a new Memory Board from Beckwith Electric, specify the new settings required. When the new board is received, remove the old board by carefully sliding it out of its slot (see Figure 7). If you are exchanging Memory Boards, place the old Memory Board in the antistatic bag and shipping carton and return to Beckwith Electric if credit is desired. Install the new board, assuring that the settings specified agree with those listed on the label supplied with the new board. To install the new board, carefully slide the board into the proper slot; the connectors are keyed so that the board cannot be put in incorrectly. Attach the new setpoint label over the old label located on the inside wall of the PRIDE Unit.

## M-0297/M-0397 FIELD ADJUSTMENT UNIT OPTION

The Field Adjustment Unit consists of the M-0297 PRIDE Control Unit and the M-0397 EE PROM Board. The M-0397 is a printed circuit board that is permanently installed in the PRIDE and is used to store the programmable setpoints. The M-0297 is a keyboard and display that can be permanently mounted with the M-0397 or can be temporarily mounted so that the relay settings can be changed. Once the limits have been set on the M-0397, the M-0297 can be unplugged and used to program the settings on other PRIDE Units. The Field Adjustment Unit can be used to monitor conditions such as line frequency and timer progress, to enable or disable certain functions, as well as interrogating setpoints and trip targets.

NOTE: When ordering the PRIDE Unit with the Field Adjustment Unit, the user must specify a set of default settings that will be used if the M-0397 is later removed from the PRIDE.

# **MAINTENANCE**

Due to the extremely sophisticated nature of the circuitry in the PRIDE Units, field repair, other than that listed below, is not recommended. All units are fully calibrated at the factory. There are no user calibration points on the PRIDE Units. In the event that a unit does not operate properly, it should be established that the problem is caused by malfunction of a Beckwith unit and not caused by an external fault or wiring error. Once this is assured, the defective circuit board or entire unit should be returned to Beckwith Electric. Pack the unit carefully (in the original carton, if possible), assuring that there is adequate packing material to protect the contents. If a circuit board is being returned, place it in the anti-static bag provided with the original carton.

NOTE: Any equipment returned for repair must be sent with transportation charges paid. The equipment must remain the property of the user. The warranty is void if the value of the unit is invoiced to Beckwith Electric at the time of return or if the unit is returned with transportation charges collect.

If under warranty, units will be repaired rapidly and returned at no cost and with return transportation paid if the fault is found to be due to workmanship or failure of material. If a unit is under warranty and express shipment for return of the repaired unit is requested, shipping charges will be billed at the current rate. If the fault is due to abuse or misuse or is out of warranty, a modest charge will be made. Repair can normally be expected to take two weeks, plus shipping time. If faster service is required, it should be requested at the time of return.

To help in analyzing the problem, a complete description of the malfunction and conditions leading to the failure should be included with the unit.

## M-0315 PRIDE TEST ADAPTER

The M-0315 Test Adapter is used to ease the connection of external test equipment to the PRIDE for test purposes.

The M-0315 Test Adapter is used to functionally test the operation of the M-0290 and M-0296. The M-0315 consists of a phenolic enclosure containing fourteen five-way binding posts and a five foot extension cable with two polarized plugs that connect to the PRIDE Power Input section. The binding posts are color coded to indicate polarity where it is applicable (the red posts indicate the Hot or Positive side) and labeled to directly correspond to the M-0290 and M-0296 rear terminal block connections.

## TROUBLESHOOTING

POWER SUPPLY

If the front panel ROWER OK LED is not lit, the following should be checked.

1. Is 120 V ac or correct value dc applied to the input terminal block TB1-3 (HOT/+) to TB1-4 (NEDTRAL/-)?

- 2. Is the Input/Output Cable properly plugged into the power input assembly (TB1 to J1)?
  - If the cable or connector appears to be defective, return it to the factory for repair.
  - NOTE: The Input/Output Cable is <u>not</u> interchangeable between an M-0290 and an M-0296.
- 3. Are the fuses installed properly and not blown?

The PRIDE®Units contain fuses on the power and potential inputs. These fuses are located on the front edge of the printed circuit board at the top of the power input compartment (see Figure 7 and Figure 16). To check these fuses, remove the power from the unit by disconnecting connector Jl. Pull the fuses from their sockets and check their continuity with an ohmmeter. If a fuse is determined to be open-circuited, replace that fuse and recheck the operation of the unit. Spare fuses are taped to the inside of the bottom compartment of the PRIDE. Additional fuses are available from Beckwith Electric. Refer to Table 3 for ordering information.

NOTE: Units returned with only a blown fuse are not covered by warranty, and a nominal repair charge will be made for replacement of the fuse. Please check the fuses before returning the PRIDE for repair in order to avoid unnecessary repair charges.

Component	Beckwith Electric Number	Description
Fl	42719	Plug-in Microfuse, 1 A, Littelfuse 273.001
F2	42725	Plug-in Microfuse, 1/2 A, Littelfuse 273.500

CAUTION: Be careful to replace the fuses only with an identical replacement.

Do not replace a 1/2 A fuse with a 1 A fuse or vice-versa.

## TABLE 3 Replacement Fuses

If the above procedure has been followed, and the POWER OK LED is still not lit, return the unit to the factory.

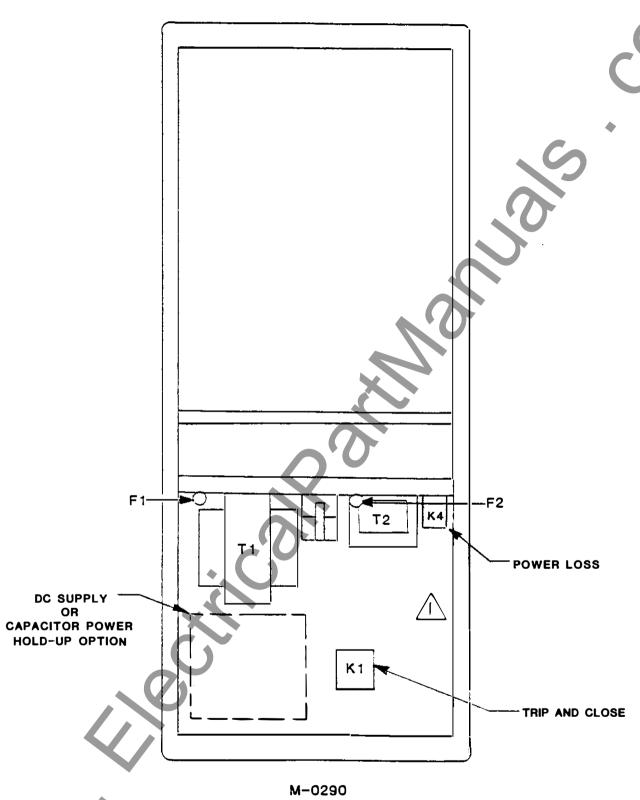
If the POWER OK LED is lit, but the unit does not operate, assure that the M-0298 Memory Board is plugged in completely. If the Field Adjustment Unit is being used, be sure that the M-0397 EE PROM Board is plugged in properly.

## OUTPUT RELAY

The output relay is located at the bottom of the Power Input section. This is a commercially available octal socket relay and can be removed from the PRIDE and checked for proper operation. The relay requires 12 V dc across the coil to operate.

## INTERNAL CABLES

Assure that J3 and J4 Connector Cables are plugged in completely.



SPARE FUSES ARE TAPED TO THE INSIDE OF THE ENCLOSURE IN THIS COMPARTMENT

FIGURE 16 Location of Input Fuses & Output Relays

## SELF-TEST INDICATORS

The LEDs on the front panel are used to indicate Self-Test failures by flashing at approximately 2 cycles per second when an error is detected (refer to Figure 17). The Self-Test errors are described in the following sections.

#### ROM Failure

Indicates that the external ROM (Read Only Memory) on the M-0298 Memory Board has failed. This can be caused by improper programming of the ROM or a partially erased or defective ROM.

CORRECTIVE PROCEDURE: Assure that the M-0298 Memory Board is properly plugged into the unit. If the light continues to flash, replace the M-0298 board. If this does not correct the problem, return the PRIDE\*Unit to the factory.

#### RAM Failure

Indicates that the internal microprocessor RAM (Random Access Memory), external RAM or the M-0397 RAM (if using the Field Adjustment Unit) has failed.

CORRECTIVE PROCEDURE: Assure that the M-0298 (and M-0397 if using the Field Adjustment Unit) boards are properly plugged into the unit. If the light continues to flash, replace the board or return the PRIDE Unit to the factory for repair.

## Operating System Failure

This failure mode indicates that the normal processing flow has been upset.

CORRECTIVE PROCEDURE: Assure that the M-0298 (and the M-0397 if using the Field Adjustment Unit) boards are properly plugged into the unit. If the light continues to flash, replace the board or return the unit to the factory.

## Power Loss/Frequency Sample Failure

Signaled by a loss of zero crossings on the frequency measuring input to the microprocessor. Caused by extremely low voltage on the potential input, an unconnected potential input or a grossly out of specification frequency measurement.

CORRECTIVE PROCEDURE: Assure that all potential inputs are properly connected. Check to see if the potential input fuse has blown. If the light continues to flash, return the unit to the factory.



CAUTION: Prior to applying power to the unit, double-check all connections to ensure that no wires are pinched or broken and that all the boards are plugged in completely.

## FUNCTIONAL TEST PROCEDURE

## EQUIPMENT REQUIRED

- A single-phase power source with frequency range variable from 55 Hz to 65 Hz and an accuracy of ±.005 Hz or better; variable voltage from 60 V rms to 150 V rms with amplitude stability of ±0.25% or better.
- 2. A Digital multimeter Hewlett-Packard 3466A or equivalent.
- 3. A stopwatch or any accurate timing device.
- 4. A fixed 120 V, 60 Hz (or 125, 48 or 24 V dc if the Dc Supply is installed), 25 W power source for the power supply input.

# UNDER OVER OVER



FIGURE 17 Self-Test Error Indicators

NOTE: The M-0315 PRIDE® Test Adapter can be used to simplify connections to the M-0290 for testing.

#### CONNECTION PROCEDURE

- 1. Connect the fixed 120 V, 60 Hz ac power to TB1-3 (HOT) and TB1-4 (NEUTRAL). If the PRIDE has a Dc Supply, connect dc power to TB1-3 (+) and TB1-4 (-).
- 2. Be sure that the variable voltage and frequency source is turned off before connecting it to the Sensing (potential) inputs TB1-5 (NEUTRAL) and TB1-6 (HOT).

#### INPUT LOSS/FREQUENCY SAMPLE FAILURE SELF-TEST

- Turn on the power supply. Verify that the UNDER FREQUENCY LED blinks five consecutive times, stops for about 1 sec, then repeats. In this Self-Test mode, the LED will continue to blink until the potential input voltage is detected.
- Turn on the potential input and adjust to 120 V ac, 60 Hz. Skip Step 3 if the LED remains off, indicating that the system is operating correctly.
- 3. If any LED continues to blink after several seconds, this indicates the M-0290 has failed the Self-Test mode. Refer to the SELP-TEST INDICATORS section, then check the external wiring, connector orientation and fuses. If an LED continues to flash, the unit is defective.
  - NOTE: If the M-0297/M-0397 Field Adjustment Unit is present, various setpoints and timer delay values (especially the Reconnect Timer) can be changed to speed up testing. In addition, frequency values and timer progress can be monitored as part of a test procedure. Refer to the M-0297/M-0397 Instruction Book for further details.

#### UNDER/OVER FREQUENCY DETECTION

- Slowly decrease the frequency of the potential input from 60 Hz until the UNDER FREQUENCY LED turns on.
- 2. The measured frequency level should be equal to the Under Frequency setpoint ±0.02 Hz.
- 3. Return the input frequency to 60 Hz.
- 4. Slowly increase the input frequency from 60 Hz until the OVER FREQUENCY LED turns on.
- 5. The measured frequency level should be equal to the Over Frequency setpoint ±0.02 Hz.
- 6. Return the input frequency to 60 Hz.

# UNDER/OVERVOLTAGE DETECTION

- 1. Slowly decrease the input voltage from 120 V until the UNDERVOLTAGE LED turns on.
- 2. The measured voltage should be equal to the Undervoltage setpoint ±2%.
- 3. Return the input voltage to 120 V.
- 4. Slowly increase the input voltage until the OVERVOLTAGE LED turns on.
- 5. The measured voltage should be equal to the Undervoltage setpoint ±2%.

6. Return the voltage to 120 V.

## RECONNECT TIMER

- 1. Decrease the frequency until the UNDER FREQUENCY LED turns on and output relay Kl changes state.
- 2. Slowly return the frequency to within the Under Frequency limit's etting and begin timing when the UNDER FREQUENCY LED turns off; stop timing when the K1 relay again changes state.
- The measured reconnect time delay should be ±0.5 sec or ±1% of the calculated Total Time Delay, whichever is greater.

## TRIP TIMERS

NOTE: The Trip Timers can be measured using a stopwatch per the following procedure if the time delay settings are at least 1 sec. If the time delays are faster than 1 sec, a timer is required that is initiated by the change in the input condition and is stopped by the PRIDE output contact.

## Overvoltage Trip Timer

- 1. Quickly raise the input voltage from 120 V to about 10% higher than the Overvoltage setpoint.
- The measured time delay should be 1/2 cycle or ±1% of the calculated Total Time Delay, whichever
  is greater.

## Undervoltage Trip Timer

- 1. Return the input to 120 V and wait for the Kl relay to change state.
- 2. Lower the input to about 10% below the Undervoltage setpoint.
- The measured trip time delay should be 1/2 cycle or ±1% of the calculated Total Time Delay, whichever is greater.

# Over Frequency Trip Timer

- 1. Quickly jump the frequency from 60 Hz to approximately 0.5 Hz above the Over Frequency setpoint.
- 2. The measured trip time delay should be 1/2 cycle or  $\pm 1\%$  of the calculated Total Time Delay, whichever is greater.

# Under Frequency Trip Timer

- 1. Quickly jump the frequency from 60 Hz to approximately 0.5 Hz below the Under Frequency setpoint.
- The measured time delay should be 1/2 cycle or ±1% of the calculated Total Time Delay, whichever
  is greater.
- 3. Return the input frequency to 60 Hz.

## M-0297/M-0397 FIELD ADJUSTMENT UNIT INSTALLED IN THE M-0290

#### M-0397 TRIP TARGETS

- Push the RESET TARGET pushbutton, located at the right top corner of M-0290, to erase the previous trip targets that were stored in the nonvolatile RAM (EE PROM) memory.
- Increase the input voltage level until the OVERVOLTAGE LED turns on and wait for the Kl relay to change state.
- 3. Lower the voltage until the CVERVOLTAGE LED turns off and the Kl relay again changes state.
- 4. Push the TARGET pushbutton; the OVERVOLTAGE LED should turn on. Release the pushbutton and the LED should turn off.
- Drop the input frequency until the UNDER FREQUENCY LED turns on and wait for the output relay to Change state.
- 6. Return the frequency to 60 Hz and push the TARGET pushbutton again. This time the UNDER FREQUENCY LED should turn on and the OVERVOLTAGE LED should remain off.
- 7. Push and release the RESET TARGET button, then push the TARGET button again. All LEDs should remain off, indicating that the previous trip status has been erased.

#### M-0297 PRIDE CONTROL UNIT

- Be sure that the cable on the M-0297 PRIDE\*Control Unit is properly installed in the socket on the M-0397 board. If the Control Unit is not plugged in, turn the power switch to OFF before connecting the unit.
- Refer to Table 3 "Valid Show Status Function Numbers" in the M-0297/M-0397 Instruction Book and check each function.
- 3. Refer to Table 2 "Valid Read Setpoint Function Numbers" and check the ROM Default Setpoints to verify that they match those recorded on the label in the bottom compartment of the M-0290. Record the number of RAM Store Cycles (Function Number 39).
- 4. Using Table 1 "Valid Change Setpoint Function Numbers", change a setpoint.
- 5. Remove power from the M-0290, then reapply.
- 6. Using Table 2, verify that the setpoint changed in step 4 was stored properly (i.e., remembered after power was removed from the unit).
- 7. Using the Read Setpoint Function Number 39, check that the number of RAM Store Cycles has been incremented by one.

## FUNCTION ENABLE

 Using function Number 18 from Table 2, check that the proper Function Enable value is stored in the memory.

# **DESIGN CHANGES**

Beckwith Electric maintains a system whereby our customers can be aware of design changes in any of our units. Full documentation on any unit is kept on file by Model Number, Serial Number and, with our microprocessor-based relays, by Software Version.

All units have a Model Number, consisting of a letter and four numbers. Complex changes are recorded by adding a suffix letter. The rule is that it must be possible to use any later version as a replacement for an earlier version. The opposite may not be true because of features added. If later units are not interchangeable for older units, a change in the Model Number is made.

Some simple changes are recorded by Serial Numbers, for example, changes in the detailed rating or manufacturer of a component where either the new or old part will perform properly.

In addition, changes in Software Versions are recorded by Software Version numbers (for example D0002V02.00).

The following describes the changes that have taken place on the PRIDE Units.

## I. M-0290, SERIAL NUMBERS 0001 TO 0009

These units were originally supplied with Software Version D0001V01.XX. This version is not compatible with the Field Adjustment Unit M-0297/M-0397. In order to use the Field Adjustment Unit, the M-0290 relays must be updated. Return the PRIDE to Beckwith Electric for modification if you wish to use the Field Adjustment Unit.

## II. M-0290, SERIAL NUMBERS 0010 TO 0048, EXCLUDING 0034, 0042, 0043 AND 0044

Relays in this group were originally supplied with software version D0001V01.XX. This software cannot be used with the Field Adjustment Unit. This version does not incorporate all the features described in this book. The unit can be returned to the factory for a modification. Part of the modification will include updating the software for use with the Field Adjustment Unit.

## III. M-0290A

These units were supplied with Software Version D0001V02.XX. These units may be used with the Field Adjustment Unit M-0297/M-0397 with the M-0397 software version number D0005V00.XX. This combination will incorporate most features described in this manual. If any of the later software features (those incorporated in the M-0290B or M-0290C) are desired, a software update can be ordered.

## IV. M-0290B

The internal grounding on these units was changed to separate signal and power grounds for improved accuracy of the frequency and voltage measurement.

## V. M-0290B SERIAL NUMBERS 0042, 0051, 0079, 0084, 0105 AND UP

Units with these serial numbers are supplied with a larger terminal block which is mounted vertically on the rear of the PRIDE when the Semiflush Mounting Option is ordered (see Figure 9).

## VI. M-0290C

This is the current version of the PRIDE\*relay, incorporating all the features described in this manual. This software will work with the M-0397 EE PROM Boards with software D0005V01.XX, but will not work with any M-0397 with D0005V00.XX software due to added features.

The following is list of the latest design changes:

## HARDWARE

- 1. Designed new box and cover for easier Semiflush Mounting.
- 2. Added mounting holes for Dc Supply.
- 3. Modified the transient protection to allow the unit to pass the Fast Transient Test.
- 4. Added the Power Loss relay (K4).

#### SOFTWARE

## D0001V03.XX

- Added a software Trip Counter and storage of the last Self-Test Error (see M-0297/M-0397 Instruction Book).
- Changed the operation of the front panel LEDs so that all LEDs, except the POWER OK LED, will remain off as long as the parameters are within the relay setpoints. LEDs will light when the parameters go out of the setpoint range (D0001V03.01 and higher).

#### D0001V04.XX

This is the current software version. It incorporates all the above mentioned features plus:

- 1. Added ability to program the Output Relay configuration.
- 2. Changed the operation of the Trip Targets (see M-0297/M-0397 Instruction Book).
- 3. Improved input noise immunity ( F Transient Protection).
  - NOTE: A software update for the M-0290 can be accomplished by exchanging the Memory Board M-0298 located in the Expansion Bus of the relay. Refer to the FIELD ADJUSTMENT section of this manual for this procedure. The Memory Board is marked near the connector fingers on the component side of the board with the numbers "P-0586" and "BE#45064". Be sure to consult the factory for details on the update procedure.
  - CAUTION: Do not swap The M-0298 Memory Board or the M-0297 EE PROM Board between PRIDE models with suffix "A" or "B" and those with suffix "C", since this will cause the PRIDE to misoperate.

# WARRANTY

Seller hereby warrants that the goods which are the subject matter of this contract will be manufactured in a good workmanlike manner and all materials used therein will be new and reasonably suitable for the equipment. Seller warrants that if, during a period of two years from date of shipment of the equipment, the equipment rendered shall be found by the Buyer to be faulty or shall fail to perform in accordance with Seller's specifications of the product, Seller shall at his expense correct the same, provided however that Buyer shall ship the equipment prepaid to Seller's facility. The Seller's responsibility hereunder shall be limited to the replacement value of the equipment furnished under this contract. The foregoing shall constitute the exclusive remedy of the Buyer and the sole liability of the Seller and is in lieu of all other warranties, whether written, oral, implied or statutory, except as to the title of the Seller to the equipment furnished. No implied statutory warranty of merchantability or of fitness for a particular purpose shall apply. Seller does not warrant any product or services of others which Buyer has designated.

SELLER MAKES NO WARRANTIES EXPRESSED OR IMPLIED OTHER THAN THOSE SET OUT ABOVE. SELLER SPECIFICALLY EXCLUDES THE IMPLIED WARRANTIES OF MERCHANTIBILITY AND FITNESS FOR A PARTICULAR PURPOSE. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF. IN NO EVENT SHALL SELLER BE LIABLE FOR CONSEQUENTIAL, EXEMPLARY, OR PUNITIVE DAMAGES OF WHATEVER NATURE.

Any equipment returned for repair must be sent with transportation charges prepaid. The equipment must remain the property of the Buyer. The aforementioned warranties are void if the value of the unit is invoiced to the Seller at the time of return.

# INDEMNIFICATION

The Seller shall not be liable for any property damages whatsoever or claims of any kind whether based on contract, warranty, tort including negligence or otherwise, or for any loss or damage arising out of, connected with, or resulting from this contract, or from the performance or breach thereof, or from all services covered by or furnished under this contract.

In no event shall the Seller be liable for special, incidental, exemplary or consequential damages including, but not limited to loss of profits or revenue, loss of use of the equipment or any associated equipment, cost of capital, cost of purchased power, cost of substitute equipment, facilities or services, downtime costs, or claims or damages of customers or employees of the Buyer for such damages, regardless of whether said claim or damages is based on contract, warranty, tort including negligence or otherwise.

Under no circumstances shall the Seller be liable for any personal injury whatsoever.

It is agreed that when the equipment furnished hereunder or any services furnished hereunder are to be used or performed in connection with any nuclear installation, facility, or activity, Seller shall have no liability for any nuclear damage, personal injury, property damage, or nuclear contamination to any property located at or near the site of the nuclear facility. Buyer agrees to indemnify and hold harmless the Seller against any and all liability associated therewith whatsoever whether based on contract, tort, or otherwise. Nuclear installation or facility means any nuclear reactor and includes the site on which any of the foregoing is located, all operations conducted on such site and all premises used for such operations. It is the intention of the parties that this is a complete indemnification and hold harmless agreement in regard to all claims arising from nuclear operations of Buyer.

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