54

DEF's Responses to Staff's Fifth Set of Interrogatories, Nos. 8-14.

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Fuel and purchased power cost recovery clause with generating performance incentive factor	Docket No. 20210001-EI Dated: October 13, 2021

DUKE ENERGY FLORIDA, LLC'S RESPONSE TO STAFF'S FIFTH SET OF INTERROGATORIES (NOS. 8-14)

Duke Energy Florida, LLC ("DEF") responds to the Staff of the Florida Public Service Commission ("Staff") Fifth Set of Interrogatories (Nos. 8-14) as follows:

INTERROGATORIES

8. Please refer to DEF witness Dean's actual/estimated testimony filed on July 27, 2021, Page 4, Line 21 through Page 5, Line 2.

   a. Please provide the amount of repair costs associated with the Crystal River 4 outage. As a part of this response categorize all necessary repairs with their costs.

Response:
This question is outside the scope of Docket No. 20210001 since it refers to repair costs which are a base rate matter. DEF is not collecting, or proposing to collect, the repair costs through the fuel clause.

9. Please refer to DEF witness Lewter's direct testimony filed on March 16, 2021, Page 4, Lines 1 – 7 and Exhibit MIL-1T, Page of 2 of 22. Please provide the Generation Performance Incentive Factor (GPIF) penalty associated the Crystal River 4 outage.

Response:
DEF witness Lewter's direct testimony filed on March 16, 2021, and the associated Exhibit MIL-1T provide the Generating Performance Incentive Factor (GPIF) reward amount and supporting schedules for the period of January through December 2020. Crystal River 4

was not included in the GPIF program during this time period and, as such, a penalty is not applicable for this unit.

10. Please refer to DEF's Response to OPC's 1st Set of Interrogatories, No. 6 and DEF witness Simpson's actual/estimated testimony filed on July 27, 2021, Exhibit JS-1, page 2 of 9. Was DEF's Citrus combined-cycle power plant outage included in the Crystal River 4 replacement power calculation? If not, provide replacement power costs with the inclusion of the Citrus combined-cycle power plant outage.

Response:
No. The Citrus CC outage was not included in the CR4 replacement power calculation. Citrus CC was down less than 13 hours and any associated replacement power costs are negligible.

11. Please refer to DEF witness Simpson's actual/estimated testimony filed on July 27, 2021, Page 7, Lines 3 -4.

a. Provide the operator's experience and training regarding power plant operations.

Response:
The Operator was an apprentice at Crystal River South (CRS - Units 1 and 2) in 2006, and became a journeyman in 2010. The Operator was then at Crystal River North (CRN - Units 4 and 5) from 2010-2013, then back at CRN in 2017. From 2013-2017, the operator was employed with another utility performing similar work.

b. Provide the operator's training history. As a part of this response, provide the last time the operator was trained in manual synchronization.

Response:
Please see the training record bearing bates numbers 20210001-DEF-000075 through 20210001-DEF-000086. Trainings which may have included generator operation and synchronization are highlighted. There is not a specific training

course for "Generator Synchronization". On the Job Training (OJT) is not specifically documented nor are simulator sessions.

For the following questions please refer to witness Simpson's actual/estimated testimony Exhibit JS-1, Root Cause Analysis Report filed on July 27, 2021.

12. Please refer to page 2 of 9 of Exhibit JS-1.

a. Explain the proper procedure for operators to follow after a failed auto synchronization attempt. As a part of this response, explain if there are separate procedures for multiple failed auto synchronization attempts.

Response:
There are several plausible failure modes (failure of voltage matching, system voltage outside of sync window, generator voltage outside of sync window, failure of speed/frequency controls, etc.) so a procedure encompassing all credible failure modes would be prohibitively difficult to develop, and offering an opinion on all proper steps to follow without understanding what failure mode led to the failed synchronization and other variables at play in a given situation would require a large amount of speculation. That said, following a failed synchronization attempt, the standard procedure for the operators would be to perform a walkdown to inspect the various potential failure modes in turn; if an issue is discovered, it is corrected, the system is reset, and synchronization is attempted again. If that attempt fails, the process begins again until synchronization is completed. During this process, proper breaker control handle position (green or red flag) should be observed . Since the time of this event, as discussed in response to 14a, below, the start-up procedures have since been revised and now include a requirement to inform the Operations Superintendent or Plant Manager in the event of multiple failed syncs.

b. When, and under what circumstances, was the last instance that manual synchronization was utilized at Crystal River 4?

Response:

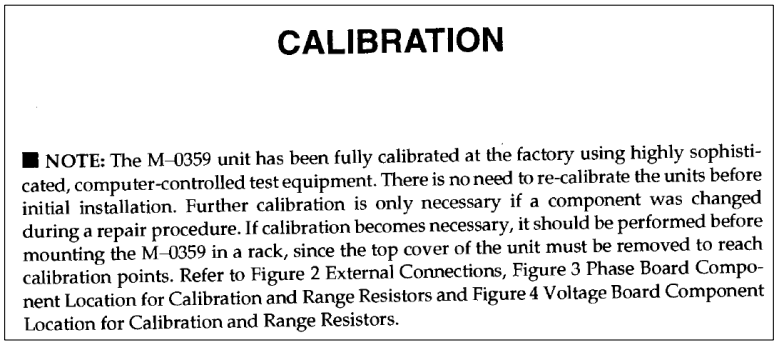
There is not a specific entry in DEF's records that indicate which method was used for each synchronization event. Since both methods are procedurally permitted (and have always been procedurally permitted) there would not be anything that kept track of normal procedural conformance.

Since the event, there have been several successful manual synchronizations, including post maintenance testing and performance of corrective actions in the RCA. As recently as July 16, 2021, a manual synchronization was performed for purposes of observation on the job training of newly hired Operators.

13. Refer to page 3 of 9 of Exhibit JS-1.

a. Provide a list of inspection dates for Manual Sync Check Relay model M-0359 (25A1) serial #1711. As a part of this response, provide the maintenance interval for this equipment.

Response:
Please see accessible calibrations from 2011, 2014, 2018, and 2020, bearing bates numbers 20210001-DEF-000087 through 20210001-DEF-000144.



CALIBRATION

■ **NOTE:** The M–0359 unit has been fully calibrated at the factory using highly sophisticated, computer-controlled test equipment. There is no need to re-calibrate the units before initial installation. Further calibration is only necessary if a component was changed during a repair procedure. If calibration becomes necessary, it should be performed before mounting the M–0359 in a rack, since the top cover of the unit must be removed to reach calibration points. Refer to Figure 2 External Connections, Figure 3 Phase Board Component Location for Calibration and Range Resistors and Figure 4 Voltage Board Component Location for Calibration and Range Resistors.

The M-0359 is a non-NERC BES component, meaning it is not required to be tested on the 6-year time frame mandated by NERC; notwithstanding, the component has been calibrated more frequently than NERC would have required, and more often than the manufacturer recommends.

b. Detail the typical life expectancy for a Manual Sync Check Relay model M-0359.

Response:
There is no manufacturer published life expectancy for M-0359.

c. Explain why the Operations Team Supervisor did not inform the operators of the modified relay panels.

Response:
It is unknown why this specific OTS did not have this specific conversation with the on-shift crew. The line relay panels have a laminated guide affixed to the panel as a job aid to assist with reset process.

d. Provide a full timeline of Crystal River Unit 4 outage event.

Response:
Refer to RCA Section II for timeline up to January 7th. Additional CR4 milestone dates associated with generator outage are as follows.
January 7th - 19th: Lock Out Tag Out, Partial Disassembly, Inspect, Test Rotor
January 21st: Rewind Determination Completed and Contract Evaluation/Selection
January 26th: Generator Disassembly
January 28th: Rotor Shipment to St. Louis facility
February 4th - March 8th: Rotor Repairs in St. Louis facility
March 8th: Ship rotor from St. Louis back to Crystal River
March 15th - March 21st: Generator Reassembly and Restoration
March 22nd/23rd - Unit 4 Startup
March 25th 06:05 AM: Unit 4 Synchronized to Grid (in AUTO Sync Mode)

14. Please refer to page 4 of 9 Exhibit JS-1.

a. Refer to Contributing Cause A3B3C06. Explain if contacting the Operations Superintendent and/or Station Manager was the proper procedure at the time of the incident. As a part of this response explain if this has changed since the time of the incident.

Response:
Contacting Operations Superintendent and/or Station Manager was not part of OI-1 (Startup Procedure) at the time of the event. At the time of the event, the governing revision was Revision 12 (Issued May 2020).

Since this event, Revision 13 has been revised to include guidance/steps for failure of expected breaker closure response as part of 13.2.1.7 and its associated substeps.

_____	13.2.1.7	**IF** closing the generator breaker on unit 4, **THEN RED FLAG SET (CLOSE)** generator output breaker 3233 or 3234 **WHEN** the sync scope is as the 11 o'clock position. (The amber light will energize because the flag is set, but the breaker has not been closed by the relay yet. Red flag setting the output breaker control handle will send a signal to the relay to close breaker 3233 or 3234).
	_____	A. **VERIFY** that the relay closes in the selected generator breaker.
		1. **IF** breaker fails to close on first attempt, then perform the following: a. **INCREASE OR DECREASE** voltage to better match system voltage. b. **INCREASE OR DECREASE** turbine speed by one or two rpm (based on speed of sync scope rotation). 2. **IF** breaker fails to close after performing the above steps, **THEN** contact the Operations Superintendent a. **IF** the Operations Superintendent is unavailable, **THEN** contact the Plant Manager. _____ _____/_____ Person Notified Date Time

b. Refer to Contributing Cause A5B2C08. Explain why Enclosure 5 of the Start-Up Procedure was incomplete.

Response:
The procedure contained all relevant information, it was only incomplete in the sense it did not direct the operator back to the main body of the procedure after completing Enclosure 5.
That is, Rev. 12, procedure step 13.2, directed the Operator to Enclosure 5 for Manual Sync guidance, but did not then direct the operator back to the main body of the procedure, which completes the manual synchronization steps. Rev 13 of the procedure has been issued to increase usability of these sections as a corrective action stemming from this event.

c. Refer to Contributing Cause A485C09. Explain why the laminated generator synchronizing guidance (operator aid) did not exist for unit 4.

Response:
DEF believes the disparity is due to the differences between Units 4 and 5. The laminated operator aid for Unit 5 addressed major modifications to Unit 5 (made during substation modernization activities in 2017) which reduced the Unit to single generator output breaker configuration and also removed the capability for Unit 5 to be manually synchronized). The purpose of the laminated operator aid was likely to assist Unit 5 Operators to understand the effects of those differences. The Unit 4 substation modernization was unlike the Unit 5 substation modernization in that it did not change the number of output breakers or the available synchronization methods (AUTO or MANUAL), so therefore no interim description or operational change was required to be communicated to the Operators.

Training Code	Title	Type	Last Completion Date
TRF006-N 00000-N	TRF006-N 00000-N Sec	ILT Class	6/1/2001
TRF007-N 00000-N	TRF007-N 00000-N Sec	ILT Class	9/1/2001
TRF008-N 00000-N	TRF008-N 00000-N Sec	ILT Class	12/1/2001
TRF001-N 00000-N	TRF001-N 00000-N Sec	ILT Class	3/1/2002
TRF002-N 00000-N	TRF002-N 00000-N Sec	ILT Class	6/1/2002
TRF003-N 00000-N	TRF003-N 00000-N Sec	ILT Class	9/1/2002
GNB0001C-N 0042-N	GNB0001C-N 0042-N C	ILT Class	11/26/2002
TRF004-N 00000-N	TRF004-N 00000-N Sec	ILT Class	12/1/2002
GNB01N-N	GNB01N-N PLANT ACC	eLearning	12/16/2002
FWB01G-N	FWB01G-N HOT WORK	eLearning	12/17/2002
GNB02N-N	GNB02N-N RAD WORK	eLearning	12/17/2002
ST0029-N	ST0029-N CR3 FIREWA	eLearning	12/17/2002
ST0055CB-N	ST0055CB-N FOREIGN	eLearning	12/17/2002
ST1171CB-N	ST1171CB-N CONFINEI	eLearning	12/17/2002
TSM015CB-N	TSM015CB-N Self Chec	eLearning	12/18/2002
ADC0216-N 0001-N	ADC0216-N 0001-N Ze	ILT Class	12/23/2002
ADC0216-N	ADC0216-N Zero Energ	ILT Course	12/23/2002
ST1263-N 0009-N	ST1263-N 0009-N Cr3 I	ILT Class	2/6/2003
TRF005-N 00000-N	TRF005-N 00000-N Sec	ILT Class	3/1/2003
ADC0219C-N 0001-N	ADC0219C-N 0001-N H	ILT Class	3/13/2003
ADC0219C-N	ADC0219C-N Hands Sa	ILT Course	3/13/2003
TRF000-N 0312-N	TRF000-N 0312-N Initi	ILT Class	3/14/2003
TRF000-N	TRF000-N Initial Fire B	ILT Course	3/14/2003
TRF006-N 0088-N	TRF006-N 0088-N Sect	ILT Class	6/19/2003
TRF007-N 0081-N	TRF007-N 0081-N Sect	ILT Class	7/24/2003
GNI0004C-N 0012-N	GNI0004C-N 0012-N Cl	ILT Class	9/5/2003
GNI0004C-N	GNI0004C-N CR3 Safet	ILT Course	9/5/2003
ME03G	SNORKEL LIFT/AERIAL	ILT Course	12/7/2003
TRF008-N 0083-N	TRF008-N 0083-N Sect	ILT Class	12/8/2003
SF2085	EMERGENCY RESPONS	ILT Course	12/15/2003
SF105	HAZARD COMMUNICA	ILT Course	12/15/2003
SF113	PERSONNEL PROTECTI	ILT Course	12/15/2003
SF983	SAFETY SIGNS AND TA	eLearning	12/15/2003
SF550	Stairways and Ladders	eLearning	12/15/2003
SF155-N	SF155-N Bloodborne P	eLearning	12/16/2003
MD152_P	Diversity Non Supervis	ILT Course	12/18/2003
MD152_P 0267	Diversity Non Supervis	ILT Class	12/18/2003
GNICS02C-N 0001-N	GNICS02C-N 0001-N S/	ILT Class	1/6/2004
GNICS02C-N	GNICS02C-N SAF-NGG	ILT Course	1/6/2004
MEC0002C-N 0011-N	MEC0002C-N 0011-N 1	ILT Class	1/8/2004
MEC0002C-N	MEC0002C-N 1st Qtr 2	ILT Course	1/8/2004
TRF001-N 0099-N	TRF001-N 0099-N Sect	ILT Class	2/25/2004
ENC0010G	ENV EXCELLENCE POLI	ILT Course	4/5/2004
ST1263-N 0017-N	ST1263-N 0017-N Cr3 I	ILT Class	4/22/2004

TRFA-N 0166-N	TRFA-N 0166-N Fire Br	ILT Class	6/3/2004
TRF002-N 0112-N	TRF002-N 0112-N Sect	ILT Class	6/14/2004
MEC0003C-N 0002-N	MEC0003C-N 0002-N 2	ILT Class	6/18/2004
MEC0003C-N	MEC0003C-N 2nd Qtr '	ILT Course	6/18/2004
MTSA01	MTSA Familiarization	ILT Course	6/22/2004
ORR0012F	RR Op & Safety Cert R	ILT Course	7/25/2004
ORR0012F 0017	RR Op & Safety Cert R	ILT Class	7/25/2004
TRF002-N 0129-N	TRF002-N 0129-N Sect	ILT Class	9/30/2004
TRF003-N 0102-N	TRF003-N 0102-N Sect	ILT Class	9/30/2004
ISD8024A	CLEARANCE AWARENE	ILT Course	10/13/2004
EHSPST	Plant S&T-part B Site S	ILT Course	10/13/2004
EHSPST03-N 00000-N	EHSPST03-N 00000-N I	ILT Class	10/14/2004
EHSPST03-N	EHSPST03-N Plant S&T	ILT Course	10/14/2004
OPI1301N-N 00000-N	OPI1301N-N 00000-N (	ILT Class	10/14/2004
OPI1301N-N	OPI1301N-N INITIAL CI	ILT Course	10/14/2004
ADMFGD37	Conduct of Material H	eLearning	11/9/2004
ITF0080G-N	ITF0080G-N PassPort F	eLearning	11/10/2004
ITF0081G-N	ITF0081G-N PassPort F	eLearning	11/10/2004
ITF0082G-N	ITF0082G-N PassPort F	eLearning	11/10/2004
ITF0083G-N	ITF0083G-N PassPort F	eLearning	11/10/2004
ORI0022F	Rail Incident Preventic	eLearning	11/29/2004
TRF004-N 0069-N	TRF004-N 0069-N Sect	ILT Class	12/13/2004
TRF004-N	TRF004-N SECTION 4- I	ILT Course	12/13/2004
GNI0002N-N	GNI0002N-N CONFINE	eLearning	12/15/2004
SFI0001N-N	SFI0001N-N SCWE - IN	eLearning	12/15/2004
TRF005-N 0085-N	TRF005-N 0085-N Sect	ILT Class	1/6/2005
GNI0005N-N	GNI0005N-N CLEARAN	eLearning	2/6/2005
TRFA-N 00000-N	TRFA-N 00000-N Fire B	ILT Class	2/23/2005
TRFA-N	TRFA-N FIRE BRIGADE	ILT Course	2/23/2005
TRF005-N 0091-N	TRF005-N 0091-N Sect	ILT Class	2/25/2005
TRF005-N	TRF005-N SECTION 5- I	ILT Course	2/25/2005
ST0003-N 0177-N	ST0003-N 0177-N How	ILT Class	3/28/2005
ST0003-N	ST0003-N How & Why	ILT Course	3/28/2005
ST1263-N 0030-N	ST1263-N 0030-N Cr3 I	ILT Class	3/29/2005
MTC052C-N 0004-N	MTC052C-N 0004-N CF	ILT Class	4/7/2005
MTC052C-N	MTC052C-N CR3 Main	ILT Course	4/7/2005
TRF006-N 0094-N	TRF006-N 0094-N Sect	ILT Class	4/18/2005
TRF006-N	TRF006-N SECTION 6- I	ILT Course	4/18/2005
ITF0069N-N 0003-N	ITF0069N-N 0003-N PV	ILT Class	5/9/2005
ITF0069N-N	ITF0069N-N PVX Wk M	ILT Course	5/9/2005
LD250	Peer Leadership Progr	ILT Course	6/22/2005
LD250 0127	Peer Leadership Progr	ILT Class	6/22/2005
OPR1301N-N	OPR1301N-N CLEARAN	eLearning	7/5/2005
GNB0001C-N 00000-N	GNB0001C-N 00000-N	ILT Class	7/15/2005
ST0001-N 0151-N	ST0001-N 0151-N Cran	ILT Class	7/21/2005

ST0001-N	ST0001-N CRANE TRAI	ILT Course	7/21/2005
MNC0503C-N 0009-N	MNC0503C-N 0009-N :	ILT Class	8/1/2005
MNC0503C-N	MNC0503C-N 3rd Qtr ;	ILT Course	8/1/2005
TRF007-N 0096-N	TRF007-N 0096-N Sect	ILT Class	8/5/2005
TRF007-N	TRF007-N SECTION 7- I	ILT Course	8/5/2005
GNB0001C-N 0635-N	GNB0001C-N 0635-N C	ILT Class	8/12/2005
GNB0001C-N	GNB0001C-N Crystal R	ILT Course	8/12/2005
MEI01N-N 0045-N	MEI01N-N 0045-N Sca	ILT Class	8/18/2005
MEI01N-N	MEI01N-N SCAFFOLDII	ILT Course	8/18/2005
MNI0001C-N 0002-N	MNI0001C-N 0002-N R	ILT Class	9/15/2005
MNI0001C-N	MNI0001C-N CR3 RCA	ILT Course	9/15/2005
GNI0001N-N	GNI0001N-N FOREIGN	eLearning	12/13/2005
GNR01N-N	GNR01N-N PLANT ACC	eLearning	12/13/2005
GNR02N-N	GNR02N-N RAD WORK	eLearning	12/13/2005
ST1160CB-N	ST1160CB-N SAFETY A	eLearning	12/13/2005
TRF008-N 0094-N	TRF008-N 0094-N Sect	ILT Class	12/16/2005
TRF008-N	TRF008-N SECTION 8- I	ILT Course	12/16/2005
WLI0007N-N 0025-N	WLI0007N-N 0025-N N	ILT Class	1/30/2006
WLI0007N-N	WLI0007N-N NGG WM	ILT Course	1/30/2006
SFQ0002G	SFQ0002G - SCBA Fit T	ILT Course	2/1/2006
SFQ0005G	SFQ0005G - MSA Full F	ILT Course	2/1/2006
GN6C11C-N 0106-N	GN6C11C-N 0106-N CR	ILT Class	2/2/2006
GN6C11C-N	GN6C11C-N CR3 RESPI	ILT Course	2/2/2006
MNC061C-N 0005-N	MNC061C-N 0005-N CI	ILT Class	2/16/2006
MNC061C-N	MNC061C-N CR3 Main	ILT Course	2/16/2006
SFI0004N-N	SFI0004N-N MEDICAL I	eLearning	2/27/2006
SFI0021G-N	SFI0021G-N MEDICAL-	eLearning	2/27/2006
TRF001-N 0115-N	TRF001-N 0115-N Sect	ILT Class	2/27/2006
TRF001-N	TRF001-N SECTION 1- I	ILT Course	2/27/2006
ST1263-N 0039-N	ST1263-N 0039-N Cr3 I	ILT Class	3/21/2006
ST1263-N	ST1263-N CR3 MSSV G	ILT Course	3/21/2006
TRF002-N 0133-N	TRF002-N 0133-N Sect	ILT Class	6/30/2006
TRF002-N	TRF002-N SECTION 2- I	ILT Course	6/30/2006
TRF003-N 0108-N	TRF003-N 0108-N Sect	ILT Class	8/16/2006
TRF003-N	TRF003-N SECTION 3- I	ILT Course	8/16/2006
TRST1008 0058	P&id Print Reading	ILT Class	11/5/2006
TRST1008	TRST1008 - Print Readi	ILT Course	11/5/2006
IT000002	Basic Computer Skills	ILT Course	11/6/2006
IT000002 0165	Basic Computer Skills	ILT Class	11/6/2006
TRST1056	Basic Technical Math	ILT Course	11/6/2006
TRST1056 0020	Basic Technical Math	ILT Class	11/6/2006
MEI0022G	MEI0022G - Valves Op	ILT Course	11/7/2006
MEI0022G 0037	Valves Operation Trair	ILT Class	11/7/2006
EHSEQ10 0031	Hand Tool Safety	ILT Class	11/8/2006
EHSEQ10	HAND TOOL SAFETY -	ILT Course	11/8/2006

MEB01G-N 0040-N	MEB01G-N 0040-N Ba	ILT Class	11/9/2006
MEB01G-N	MEB01G-N Basic Gene	ILT Course	11/9/2006
TRST7011 0135	Pwr Plt Steam & Mech	ILT Class	11/15/2006
TRST7011	TRST7011 - Power Plar	ILT Course	11/15/2006
TRST7075	Bearings And Lubricati	ILT Course	11/20/2006
TRST7075 0031	Bearings And Lubricati	ILT Class	11/20/2006
TRST7074	Mechanical Drives, Co	ILT Course	11/20/2006
TRST7074 0024	Mechanical Drives, Co	ILT Class	11/20/2006
TRST1051	Basic Electricity	ILT Course	11/27/2006
TRST1051 0028	Basic Electricity	ILT Class	11/27/2006
TRST7070	Measuring Instrument	ILT Course	11/28/2006
TRST7070 0044	Measuring Instrument	ILT Class	11/28/2006
POC0001G 0024	Breaker Operations	ILT Class	11/29/2006
POC0001G	POC0001G - Breaker F	ILT Course	11/29/2006
POI0002F 0028	Intro to Power Genera	ILT Class	2/8/2007
POI0002F	POI0002F - Intro to Po	ILT Course	2/8/2007
POQ0003F	Fos Clear/S&T Hanger	eLearning	3/12/2007
OPI1301F	PVX S&T/Tag Out for H	eLearning	3/12/2007
SEI0002G	MTSA Critical Staff Tra	ILT Course	4/22/2007
SEI0002G 0005	MTSA Critical Staff Tra	ILT Class	4/22/2007
PO0018F	Surviving Combustion	ILT Course	6/10/2007
PO0018F 0017	Surviving Combustion-	ILT Class	6/10/2007
SF190 4888	American Heart CPR/F	ILT Class	8/6/2007
SF190	American Heart CPR/F	ILT Course	8/6/2007
HS0277	EHST - CPR /AED/ First	ILT Course	8/7/2007
HS0276	EHST - CPR/AED/First A	ILT Course	8/7/2007
SF191-N 00000-N	SF191-N 00000-N AmH	ILT Class	8/7/2007
SF191-N	SF191-N AMERICAN HI	ILT Course	8/7/2007
FRM470 0433	ES Annual Inspection C	ILT Class	9/11/2007
TRST1035	Turbine Generator Tra	ILT Course	9/27/2007
TRST1035 0090	Turbine Generator Tra	ILT Class	9/27/2007
TRST1039	Electrical System Train	ILT Course	10/4/2007
TRST1039 0032	Electrical System Train	ILT Class	10/4/2007
ITF0123G-N	ITF0123G-N IT&T Secu	eLearning	12/18/2007
SFI0050G	DRUG, ALCOHOL AND	ILT Course	12/21/2007
CEMS12	FGD CEMS Op training	ILT Course	2/25/2008
CEMS12 0005	FGD CEMS Op training	ILT Class	2/25/2008
EHS0009 0214	Fixed Fire Exting Sys	ILT Class	3/1/2008
EHS0009	FIXED FIRE EXTING SYS	ILT Course	3/1/2008
LET01G	Lead Awareness Traini	ILT Course	3/9/2008
ME07G	SCAFFOLD USER TRAIN	ILT Course	3/9/2008
SF2069	SF2069 - Flyash Protec	ILT Course	3/12/2008
TRST7115	Digital Control System	ILT Course	4/24/2008
TRST7115 0023	Digital Control System	ILT Class	4/24/2008
MM155GH	FORKLIFT RETRAINING	ILT Course	5/19/2008

DE-103727	EHST - Order Picker Ini	eLearning	5/20/2008
DE-103728	EHST - Stand-up Reach	eLearning	5/20/2008
HS0900P-N 00000-N	HS0900P-N Fork Lift Pr	ILT Class	5/20/2008
MM155G-N	MM155G-N FORKLIFT	eLearning	5/20/2008
SEC0002	NERC Reliability Stds -	eLearning	6/16/2008
ITF0126G-N 00000-N	ITF0126G-N 00000-N I	ILT Class	8/16/2008
ITF0126G-N	ITF0126G-N IT&T Secu	ILT Course	8/16/2008
EL0018G 0081	Arc Flash PPE - Interim	ILT Class	9/8/2008
EL0018G	EL0018G -Arc Flash PP	ILT Course	9/8/2008
ADIFGD26	FGD Conduct of Oper	ILT Course	9/19/2008
ADIFGD26 0010	FGD Conduct of Oper	ILT Class	9/19/2008
SFQ0001G	SFQ0001G - 3M HALF I	ILT Course	9/30/2008
FOS001CR	FOS001CR - Simulator	ILT Course	10/9/2008
FOS001CR 0014	Simulator Startup & Sh	ILT Class	10/9/2008
ORI0018F	Ash Handling Truck Op	ILT Course	11/30/2008
ME82G	Bottom Ash Shot Gun	ILT Course	12/16/2008
SF478P 0054	Fire Extinguisher Pract	ILT Class	3/8/2009
SFI000CG-N	SFI000CG-N QUALIFIEI	eLearning	5/28/2009
SFI000EG-N	SFI000EG-N QUALIFIEI	eLearning	5/28/2009
SFI000LG-N	SFI000LG-N QUALIFIEI	eLearning	5/28/2009
SFI000NG-N	SFI000NG-N QUALIFIEI	eLearning	5/28/2009
SFI000PG-N	SFI000PG-N QUALIFIEI	eLearning	5/28/2009
SFI000SG-N	SFI000SG-N QUALIFIEI	eLearning	5/28/2009
SFI0020G-N	SFI0020G-N MEDICAL-	eLearning	5/28/2009
SFI0022G-N	SFI0022G-N HALF FACI	eLearning	5/28/2009
SFI0023G-N	SFI0023G-N MEDICAL-	eLearning	5/28/2009
SFI0024G-N	SFI0024G-N TOTAL EXI	eLearning	5/28/2009
SFI0025G-N	SFI0025G-N MEDICAL I	eLearning	5/28/2009
DIVEW01 0228	Business Case for Dive	ILT Class	7/7/2009
DIVEW01	Business Case for Dive	ILT Course	7/7/2009
DIVEW04	Generations in the Wo	ILT Course	7/7/2009
POQ0004F	PVX Tag Out for Clear I	eLearning	7/29/2009
ENC002CR	Crystal River Oil Spill T	eLearning	9/15/2009
SF149 0259	Am Heart/ASHI Adult (	ILT Class	10/20/2009
SF149	Legacy Progress CPR &	ILT Course	10/20/2009
SEC0001 0203	NERC Personnel Risk A	ILT Class	10/27/2009
EL0018I	EL0018I - Arc Flash Init	ILT Course	2/1/2010
EL0018P	EL0018P - Arc Flash Tr	ILT Course	2/1/2010
ENC0013G	STORMWATER POLLU	ILT Course	2/14/2010
TR000179	DEFENSIVE DRIVING	eLearning	6/3/2010
SF225PV	DEFENSIVE DRIVING IN	ILT Course	6/3/2010
DIVEW02	Exploring Differences i	ILT Course	8/2/2010
DIVEW02 0624	Exploring Differences i	ILT Class	8/2/2010
DIVEW05	Subtle Behaviors	ILT Course	8/2/2010
DIVEW05 0565	Subtle Behaviors for E	ILT Class	8/2/2010

ITI003F	Non-sup Auto roster c	ILT Course	8/15/2010
EHSELE03-N	EHSELE03-N Electrical	eLearning	9/21/2010
ETHICS10	Ethics In Action CBT 2(	ILT Course	9/21/2010
EHSELE01	ELECTRICAL SAFETY AV	ILT Course	9/22/2010
RESPP-N	RESPP-N Respirator Pr	ILT Course	9/23/2010
SF478P 0105	Fire Extinguisher Pract	ILT Class	9/28/2010
SF2118	CONFINED SPACE AW/	ILT Course	9/29/2010
GN6C100N-N	GN6C100N-N POG COI	eLearning	9/30/2010
EHSRAD01	Radiation Safety Traini	ILT Course	9/30/2010
FRM470 0606	ES Annual Inspection (	ILT Class	11/3/2010
EV617CR4 0001	Spill Prevention C&C -	ILT Class	11/25/2010
HR0004F 0056	Anatomy of an Event -	ILT Class	11/30/2010
CRFO001 0005	CR Scrubber Steam Op	ILT Class	12/5/2010
CRFO001	CR Scrubber Steam Op	ILT Course	12/7/2010
CRFO001 0006	CR Scrubber Steam Op	ILT Class	12/7/2010
CRFH001	Crystal River Flyash Sy	ILT Course	12/7/2010
CRFH001 0003	Crystal River Flyash Sy	ILT Class	12/7/2010
EN0102	90/180 Day/TSDF Stor	eLearning	2/13/2011
EV639CR	EV639CR - RCRA SMAL	ILT Course	2/13/2011
EN0100	Introduction to Hazarc	eLearning	2/13/2011
EN0118	Moving Hazardous Stu	eLearning	2/13/2011
EN0101	Satellite Accumulation	eLearning	2/13/2011
EV601GZ-N	EV601GZ-N DOT Spec	eLearning	2/14/2011
CRNHPI02 0001	CRN HPI Electronic Tag	ILT Class	2/14/2011
HR0004F	Anatomy of an Event -	ILT Course	3/20/2011
HR0004F 0058	Anatomy of an Event -	ILT Class	3/20/2011
CRNS01	CRN Boiler Bypass Syst	ILT Course	3/21/2011
CRNS01 0003	CRN Boiler Bypass Syst	ILT Class	3/21/2011
CRNHPI02	CRN HPI Electronic Tag	ILT Course	3/21/2011
CRNHPI02 0005	CRN HPI Electronic Tag	ILT Class	3/21/2011
CRNS02	CRN Feedwater Contrc	ILT Course	3/22/2011
CRNS02 0002	CRN Feedwater Contrc	ILT Class	3/22/2011
CRNYCON	CRN Cond. Clean. Bea	ILT Course	3/23/2011
CRNYCON 0002	CRN Cond. Clean. Bea	ILT Class	3/23/2011
CRNYPID	CRN P&ID Redlining	ILT Course	3/23/2011
CRNYPID 0001	CRN P&ID Redlining	ILT Class	3/23/2011
NGSAF01	Gas Safety Awareness	eLearning	6/18/2011
ETHCS11C	Ethics In Action CBT 2(	ILT Course	6/26/2011
LD199B	Culture in Action CBT	ILT Course	7/24/2011
VAR002C	NERC VAR002 Complia	eLearning	7/26/2011
CRNTRANS	Transformer Oper. Rev	ILT Course	9/11/2011
CRNTRANS 0002	Transformer Oper. Rev	ILT Class	9/11/2011
CRNTUROP	Turbine Retrofit / Loac	ILT Course	9/12/2011
CRNTUROP 0001	Turbine Retrofit / Loac	ILT Class	9/12/2011
ME105PV	Intrinsically Safe Equip	eLearning	12/11/2011

SF478P 0160	Fire Extinguisher Pract	ILT Class	2/28/2012
MNI0011G	Air Compressor/Dessic	ILT Course	3/4/2012
MNI0012G	Precipitator Controls	ILT Course	3/4/2012
MNI0013G	EHC Front Standard/P	ILT Course	3/5/2012
MNI0014G	Generator Core Monit	ILT Course	3/5/2012
MNI0015G	CCM Refresher	ILT Course	3/6/2012
OPR1302F	OPR1302F - Contracto	ILT Course	3/6/2012
SF2124	SF2124 - Defensive Dri	ILT Course	3/7/2012
SF2124 0019	Smith Driving Classroo	ILT Class	3/7/2012
HS2124	Smith System Driver C	ILT Course	3/7/2012
PMC-001|COT148C	NO NOT USE THIS COU	eLearning	3/8/2012
HS2125	Smith System Driver P	ILT Course	3/8/2012
SFI0206G	SFI0206G FALL PROTEC	ILT Course	3/21/2012
EV601G-N	EV601G-N DOT GEN A\	eLearning	3/22/2012
TR000170	ACCESS TO MEDICAL R	eLearning	3/25/2012
TR400446	POG Interface Agree-F	eLearning	3/25/2012
TR400460	TRM I A for Pwr Gen F	eLearning	3/25/2012
OPR1301F	PVX S&T/Tag Out for H	eLearning	3/26/2012
EV617CR1	Spill Prevention C&C -	ILT Course	4/21/2012
EV617CR4	Spill Prevention C&C -	ILT Course	4/21/2012
SFI0026G-N	SFI0026G-N AUDIOGR/	eLearning	5/31/2012
EL0018R	EL0018R - ARC FLASH F	ILT Course	8/26/2012
SFI0031G-N	SFI0031G-N HEXAVALE	eLearning	8/27/2012
CRMAGORI	Magnetrol Orion Auro	ILT Course	9/26/2012
CRMAGORI 0002	Magnetrol Orion Auro	ILT Class	9/26/2012
SF459	ASBESTOS AWARENES	ILT Course	10/5/2012
EC10612	COBE Refresher 2012	eLearning	10/19/2012
FRM470 0687	ES Annual Inspection C	ILT Class	11/5/2012
FRM470	FRM470 - ES Annual In	ILT Course	11/5/2012
ADMFGD26	FGD Conduct of Opera	ILT Course	11/6/2012
ADMFGD26 0020	FGD Conduct of Opera	ILT Class	11/6/2012
ENV0004G	Hazwoper Level I - Aw	ILT Course	11/22/2012
SEC0003	Impact NERC Stds. Pw	eLearning	11/22/2012
SEC0004	Ops Require for NERC	eLearning	11/22/2012
SF2123	Safe Driving	ILT Course	11/22/2012
ENC0015G	STORMWATER POLLU	ILT Course	11/22/2012
NERC2012	NERC Awareness Train	eLearning	12/9/2012
OPI0005F	OPI0005F - Power Gen	ILT Course	2/5/2013
OPI0005F 0015	Pwr Gen Station Mgr C	ILT Class	2/5/2013
SF2108	ACCESS TO MEDICAL R	ILT Course	3/2/2013
SF478	FIRE EXTINGUISHERS	ILT Course	3/2/2013
SF800	Hearing Conservation	ILT Course	3/2/2013
TR0113	Hearing Conservation/	ILT Course	3/2/2013
HS0418	DO NOT USE THIS COU	eLearning	3/12/2013
HS0454	DO NOT USE THIS COU	ILT Course	3/12/2013

SF478P	FIRE EXTINGUISHERS F	ILT Course	3/12/2013
PMC-001|HS0418	DO NOT USE THIS COU	eLearning	3/13/2013
GN6CEDF	Env. Awareness -Level	eLearning	3/13/2013
GN6C108G-N 00000-N	GN6C108G-N 00000-N	ILT Class	3/14/2013
GN6C108G-N	GN6C108G-N Environ.	ILT Course	3/14/2013
CEMS07	CEMS07 - CT CEMS Op	ILT Course	4/8/2013
FME100F	FGD Foreign Material I	eLearning	5/24/2013
MEI0024G	Lube Oil Awareness	eLearning	5/24/2013
EHSENV01	SPCC Spill Prevention/	eLearning	5/24/2013
EV617IG-N	EV617IG-N SPCC SPILL	eLearning	5/25/2013
SFI0200G-N	SFI0200G-N FALL PROT	eLearning	5/25/2013
HS0720	EHST - Fall Protection (	ILT Course	5/25/2013
HS0720 EHST1700030	EHST - Fall Protection (	ILT Class	5/25/2013
HS0003	EHST - Fall Protection I	eLearning	5/25/2013
DE-120764	EHST-Fall Protection T	ILT Course	5/25/2013
CIP004R2_P	NERC Cyber Sec-Critica	Material	7/28/2013
PGL677	PGL677 Backing Policy	ILT Course	8/9/2013
EC10613	CoBE Refresher Trainir	eLearning	8/19/2013
SEC0018	PGF Gene Op for Main	eLearning	8/25/2013
CIPOP4PV	POG Gen Aware Ops N	eLearning	8/25/2013
SEC0001	For NERC Admins Only	ILT Course	7/17/2017
DE-126351	DE-126351 - RRE Arc F	eLearning	7/18/2017
FHO111	FHO111 - Fossil Hydro	ILT Course	7/18/2017
FHO111 000172	FHO111 - Fossil Hydro	ILT Class	7/18/2017
IT800	Duke Energy's Top 10 !	eLearning	7/19/2017
HR0113	Maintaining a Harassn	eLearning	7/19/2017
EN1000	EHST - Environmental	eLearning	7/19/2017
LDIT111	Security Awareness fo	eLearning	7/19/2017
FHO942	FHO942 - Control of Ra	eLearning	7/19/2017
HS0089	EHST - Respirable Crys	eLearning	7/20/2017
HS0735	EHST - Radio Frequenc	eLearning	7/20/2017
EC10617	Code of Business Ethic	eLearning	7/20/2017
LD325	Sustainability 101	eLearning	7/25/2017
EHS1000	EHST - EHS Foundatior	eLearning	7/25/2017
EN0002	EHST - Hazard Commu	eLearning	7/25/2017
EN0003	Hazard Communicatio	eLearning	7/25/2017
TransEngComplFLReg	Regulatory Compliance	Objective	7/25/2017
ISW709	Information Security A	eLearning	7/25/2017
LD100	MyTraining - Learner C	eLearning	7/25/2017
PGL7700	PGL7700 - Initial Opera	ILT Course	7/27/2017
PGL7700 000003	PGL7700 - Initial Opera	ILT Class	7/27/2017
ADMF26PV	FGD Conduct Of Opera	eLearning	7/27/2017
XEHS02	XEHST - Environmenta	ILT Course	7/31/2017
XEHS02 000016	XEHST - Environmenta	ILT Class	7/31/2017
EC10317	Code of Business Ethic	eLearning	8/2/2017

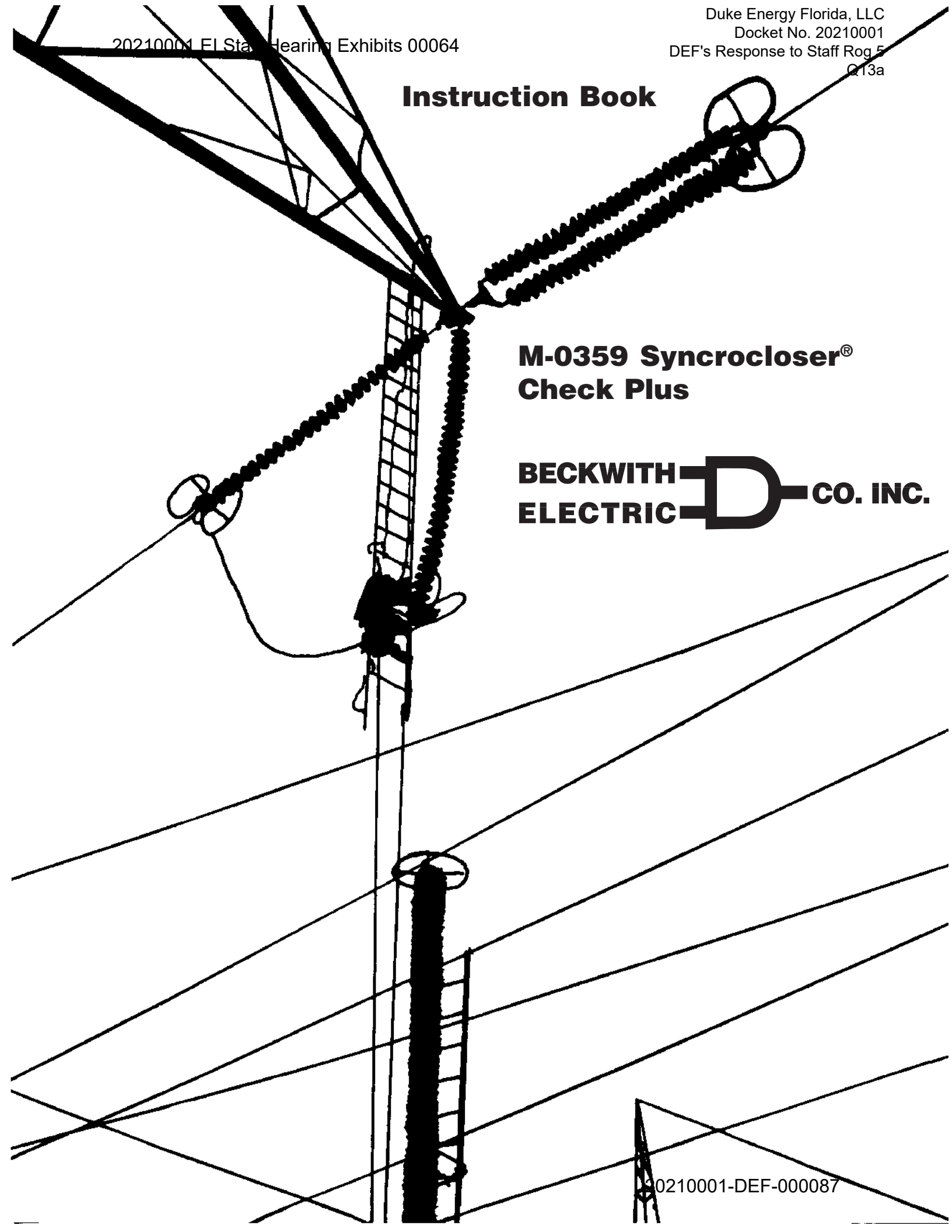
DE-121834	EHST - Thermal Stress	eLearning	8/24/2017
HS0327	EHST - Cold Stress - HS	eLearning	8/24/2017
HS0749	EHST - Personal Protec	eLearning	8/24/2017
EN0015	EHST - Chemical Inven	eLearning	8/24/2017
HS1011	Ergonomic Safety Ove	eLearning	8/24/2017
HS0136	EHST - Respirator Usag	eLearning	8/24/2017
HS0247	Asbestos, Man-made \	eLearning	8/24/2017
DE-124444	EHST - Heat Stress Gap	eLearning	8/25/2017
HS0328	EHST - Heat Stress - HS	eLearning	8/25/2017
EN0068	Migratory Bird Treaty /	eLearning	8/25/2017
HS0739	Hazard Awareness: Sli	eLearning	8/25/2017
EN0016	EHST - Chemical Inspe	eLearning	8/25/2017
EN0126	EHST - Universal Wast	eLearning	8/25/2017
EN0403	EHST - Corporate Cher	eLearning	8/25/2017
COT148C	NO NOT USE THIS COU	eLearning	8/25/2017
EN0136	EHST - Understanding	eLearning	8/25/2017
PGL690	PGL690 - LOTO Proced	ILT Course	10/3/2017
PGL690 000401	PGL690 - LOTO Proced	ILT Class	10/3/2017
PGL692	PGL692 - FHO Annual I	eLearning	10/3/2017
PGLZEV	PGLZEV - Electrical ZEV	ILT Course	10/4/2017
PGLZEV 000116	PGLZEV - Electrical ZEV	ILT Class	10/4/2017
PGL691	PGL691 - LOTO Desk Tı	ILT Course	10/4/2017
PGL691 000080	PGL691 - LOTO Desk Tı	ILT Class	10/4/2017
EC22017	NERC Awareness Train	eLearning	10/25/2017
IT816	Security Awareness fo	eLearning	10/25/2017
HS0235E	EHST - Asbestos Class I	eLearning	11/12/2017
HS0235	EHST - CLASS IV ASBES	ILT Course	11/12/2017
HS0246	EHST - Class IV Asbesto	eLearning	11/12/2017
FHOEIC201FL	FHOEIC201FL - RRE-FL	ILT Course	11/28/2017
FHOEIC201FL 170001	FHOEIC201FL - RRE-FL	ILT Class	11/28/2017
FHO722	FHO722 - Initial for No	ILT Course	1/16/2018
FHO722 000040	FHO722 - Initial for No	ILT Class	1/16/2018
FHOOSS211LAB	FHOOSS211LAB - Oper	ILT Course	2/5/2018
FHOOSS211LAB 180000	FHOOSS211LAB - Oper	ILT Class	2/5/2018
FHO2334	FHO2334 - Condensate	ILT Course	2/7/2018
FHO2334 180000	FHO2334 - Condensate	ILT Class	2/7/2018
FHONGP100	FHONGP100 - Hydroge	ILT Course	2/7/2018
FHONGP100 180000	FHONGP100 - Hydroge	ILT Class	2/7/2018
FHOGHP100	FHOGHP100 - Natural	ILT Course	2/7/2018
FHOGHP100 180000	FHOGHP100 - Natural	ILT Class	2/7/2018
PGC023	PGC023 - Continuous E	ILT Course	2/7/2018
PGC023 180001	PGC023 - Continuous E	ILT Class	2/7/2018
FHO003	FHO003 - Environmen	ILT Course	2/14/2018
FHO003 180001	FHO003 - Environmen	ILT Class	2/14/2018
EHSSWTF2	System S&T - Plant Op	eLearning	3/20/2018

DEIA001	Duke Energy In Action	eLearning	5/7/2018
FHOFL252	FHOFL252 Operator M	ILT Course	5/31/2018
FHOFL252 180006	FHOFL252 Operator M	ILT Class	5/31/2018
FHO225	FHO225 - LOTO Proced	eLearning	7/4/2018
HS0112	EHST - EHS-Basic Respi	eLearning	8/27/2018
HS0282	EHST - Electrical Safety	eLearning	8/27/2018
TransEngComplFLDep	Department Directives	Objective	8/27/2018
ENC005	EHST - Spill Prevention	eLearning	8/27/2018
HR0411	Social Media Practices	eLearning	8/27/2018
EC10618	Code of Business Ethic	eLearning	8/27/2018
HS0701	Fire Extinguisher Annu	ILT Course	8/29/2018
HS0701 000529	Fire Extinguisher Annu	ILT Class	8/29/2018
HS0081	EHST - Emergency Plar	ILT Course	8/30/2018
HS0081 000006	EHST - Emergency Plar	ILT Class	8/30/2018
HS0081E	EHST - Emergency Plar	eLearning	8/30/2018
FHO111A	Arc Flash Safety 2018 I	ILT Course	9/26/2018
FHO111A 000025	Arc Flash Safety 2018 I	ILT Class	9/26/2018
HS0142	EHST - Supported and	eLearning	10/22/2018
FHOWRKM001	FHOWRKM001 - FHO \	ILT Course	11/27/2018
FHOWRKM001 000045	FHOWRKM001 - FHO \	ILT Class	11/27/2018
HS1010	EHST - Workplace Safe	eLearning	1/25/2019
HS1003	Office Safety - EHST	eLearning	1/25/2019
HS1002	Workplace Ergonomics	eLearning	1/25/2019
IT709	Cybersecurity and You	eLearning	2/18/2019
MEI0023G	MEI0023G MOV Opera	ILT Course	3/2/2019
MEI0023R	MOV Actuators Retrng	eLearning	3/2/2019
CHA07G	Basic Fossil Plant Chen	eLearning	3/2/2019
EHSSWT1R	ED Switching & Taggin	eLearning	5/7/2019
EHSSWTR2	System S&T Retrn for I	eLearning	5/7/2019
MGS196:DE-102880	MGS196 - RRE Standar	ILT Class	6/23/2019
FHO1027	FHO1027 - RRE LOTO F	ILT Course	6/27/2019
FHO1027 000010	FHO1027 - RRE LOTO F	ILT Class	6/27/2019
DE-91611	FHO1027CBT LOTO Pro	eLearning	6/27/2019
FHONERCCIP003A	FHONERCCIP003A - CII	eLearning	9/12/2019
TTC2123-N	TTC2123-N Bloodborn	ILT Course	9/28/2019
HS0545	EHST - Bloodborne Pat	eLearning	9/28/2019
FHONERCPRC004T1	FHONERCPRC004T1 - F	ILT Course	10/31/2019
FHONERCPRC004T1:DE-1	FHONERCPRC004T1 - F	ILT Class	10/31/2019
DE-113400	DE-113400 Harassmen	eLearning	11/2/2019
LDHFWE01	Training for a Harassm	eLearning	11/2/2019
EN0065E	EHST - Approaching &	eLearning	12/30/2019
DE-101485	EC - 2019 Code of Busi	eLearning	1/16/2020
MGS196:DE-107671	MGS196 - RRE Standar	ILT Class	1/23/2020
DE-108639	DE-108639 - Crystal Ri	ILT Course	2/1/2020
DE-108639:DE-109759	DE-108639 - Crystal Ri	ILT Class	2/1/2020

PGO108	PGO108 - Combined C	ILT Course	2/19/2020
PGO108 190001	PGO108 - Combined C	ILT Class	2/19/2020
FHO693PLTW	FHO693PLTW - NERC (	eLearning	5/3/2020
DE-109696	DE-109696_COVID-19	eLearning	6/18/2020
PGL362	PGL362 - Generator O	eLearning	8/8/2020
DE-112729	DE-112729 - RRE LOTO	ILT Course	8/10/2020
DE-112729:DE-113625	DE-112729 - RRE LOTO	ILT Class	8/10/2020
DE-112728	DE-112728 - RRE LOTO	ILT Course	8/10/2020
DE-112728:DE-113597	DE-112728 - RRE LOTO	ILT Class	8/10/2020
DE-109177	Cybersecurity Awaren	eLearning	8/12/2020
DE-113441	EC - 2020 Code of Busi	eLearning	9/15/2020
FHO1031	FHO1031 -Regulated 8	eLearning	9/15/2020
DE-112202	DE-112202 - LOTO Pro	eLearning	10/2/2020
DE-103722	EHST - Introduction to	eLearning	12/9/2020
HS2014	EHST - Duke Energy Sa	eLearning	12/23/2020
HS0221	EHST - Beryllium Awar	eLearning	12/23/2020
HS0800	EHST - Fire Extinguishe	eLearning	12/23/2020
HS0802	EHST -Fire Extinguishe	ILT Course	12/23/2020
HS0702	Fire Extinguisher Annu	eLearning	12/23/2020
PGL800	PGL800 - FHO Annual I	eLearning	1/1/2021
PGL427	PGL427 - Generation P	eLearning	2/23/2021
HS9054	EHST - Emergency Sho	eLearning	2/24/2021
EN0213	EHST - DOT General Av	eLearning	2/24/2021
PGL426	PGL426 - Introduction	eLearning	2/24/2021
OPEX0001	OPEX_Pre-Job Brief Tra	eLearning	3/8/2021
HS0024	EHST - Hearing Conser	eLearning	3/8/2021
HS0088	EHST - Lead in Constru	eLearning	3/20/2021
HS0729	EHST - Portable Grinde	eLearning	3/20/2021
FHO1030	FHO1030 - Regulated 8	eLearning	3/30/2021
HS0220	EHST - Inorganic Arsen	eLearning	3/30/2021
HS0645	EHST - Waterborne Pa	eLearning	3/30/2021
HS9070	EHST - Hexavalent Chr	eLearning	3/30/2021
DE-118825	DE-118825 - RRE High-	eLearning	5/9/2021
DE-119042	DE-119042 - RRE High-	eLearning	5/9/2021
DE-118717	DE-118717 - RRE High-	eLearning	5/9/2021
DE-129402	DE-129402 - RRE LOTO	eLearning	5/15/2021
DE-118828	DE-118828 - RRE High-	eLearning	5/28/2021
DE-119124	DE-119124 ? RRE High	eLearning	5/28/2021
DE-119127	DE-119127 - RRE High-	eLearning	5/28/2021
DE-118745	DE-118745 ? RRE High	eLearning	5/29/2021
DE-129773	DE-129773 - Conveyor	Material	5/29/2021
EN0121	EHST - Hazardous Was	eLearning	6/4/2021
FHO1033	FHO1033 - Regulated 8	eLearning	6/4/2021
PGL905CBT	PGL905CBT - Radiatior	eLearning	6/4/2021
DE-129528	Cybersecurity Awaren	eLearning	6/5/2021

FHO1032	FHO1032 - Regulated {	eLearning		6/11/2021
EN0071	EHST - Migratory Bird ˙	eLearning		6/11/2021
MGS196	MGS196 - RRE Standar	ILT Course		6/17/2021
MGS196:DE-132109	MGS196 - RRE Standar	ILT Class		6/17/2021
PGL790	PGL790 - Security Incic	eLearning		6/22/2021
ENW009	EHST - Storm Water Pc	eLearning		8/19/2021
FHO970e	FHO970e - Hydrogen S	eLearning		8/28/2021
SF149 0256	Am Heart/ASHI Adult (	ILT Class	NOT COMPLETE - RLG	
SF149 0284	Am Heart/ASHI Adult (	ILT Class	NOT COMPLETE - RLG	
SF149 0519	Am Heart/ASHI Adult (	ILT Class	NOT COMPLETE - RLG	
EL0018P 0042	Arc Flash Practical	ILT Class	NOT COMPLETE - RLG	
TR0117	Basic Electricity	eLearning	NOT COMPLETE - RLG	
DIVEW01 0227	Business Case for Dive	ILT Class	NOT COMPLETE - RLG	
DE-105900:DE-129429	DE-105900 - Human P(	ILT Class	NOT COMPLETE - RLG	
FHO2111	FHO2111 - RRE Contra	eLearning	NOT COMPLETE - RLG	
GNI0007N-N	GNI0007N-N AERIAL LI	eLearning	NOT COMPLETE - RLG	
HR0003F	HR0003F - Human Errc	ILT Course	NOT COMPLETE - RLG	
HR0003F 0192	Human Error Reduct-I	ILT Class	NOT COMPLETE - RLG	
HR0003F 0246	Human Error Reduct-I	ILT Class	NOT COMPLETE - RLG	
ITF0084G-N 00000-N	ITF0084G-N 00000-N P	ILT Class	NOT COMPLETE - RLG	
ITF0084G-N	ITF0084G-N PassPort F	ILT Course	NOT COMPLETE - RLG	
ME206G-N 0298-N	ME206G-N 0298-N Init	ILT Class	NOT COMPLETE - RLG	
PGL955	PGL955 - Configuratior	eLearning	NOT COMPLETE - RLG	
ST0006-N 00000-N	ST0006-N 00000-N Pla	ILT Class	NOT COMPLETE - RLG	
ST1263-N 00000-N	ST1263-N 00000-N Cr3	ILT Class	NOT COMPLETE - RLG	
ST1263-N 0037-N	ST1263-N 0037-N Cr3 I	ILT Class	NOT COMPLETE - RLG	
TTC1417-N	TTC1417-N FME Work(	ILT Course	NOT COMPLETE - RLG	
MEI0022G 0008	Valves Operation Trair	ILT Class	NOT COMPLETE - RLG	
GNF0003G	Work Mgmt for Craft	ILT Course	NOT COMPLETE - RLG	
GNF0003G 0025	Work Mgmt for Craft	ILT Class	NOT COMPLETE - RLG	

Instruction Book



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Syncrocloser® Check Plus M-0359

- **Enhances system stability when applied to transmission and primary distribution reclosing schemes**
- **Detects a static phase angle across an open breaker in 0.5 second to assure a fast permissive for reclosure**
- **Simultaneously measures voltage magnitudes to ensure that they are within upper, lower and difference limits**
- **Includes dead line/dead bus closing features**
- **Remote command widens the phase angle setpoint to respond to system emergencies or to narrow the setpoint when the two systems are isolated to close the breaker very close to 0°**
- **Transducer analog outputs are SCADA compatible**

Industry Leader Since 1969
Made in the USA

INPUTS

1. Power is derived from either the Line or Bus input, whichever is greater. Below 65 V, the low voltage detection circuitry will shut down the M-0359.
2. Line voltage, nominal 120 V ac, 145 V ac maximum continuous. Will withstand 240 V ac for 1 sec.
3. Bus voltage, nominal 120 V ac, 145 V ac maximum continuous. Will withstand 240 V ac for 1 sec.

■ **NOTE**: Line and Bus voltage inputs are transformer-isolated, allowing complete freedom in applications.

4. Select Dead Bus Close (by closing contact)*****.
5. Select Dead Line Close (by closing contact)*****.

*****■ **NOTE**: One input must be greater than 100 V ac to ensure output relay closure.

6. Shift **PHASE ANGLE LIMIT** setpoint. An external contact closure will reduce the setpoint by a specified ratio. This can also be used as a widening function by operating with the external terminals normally closed.
7. Enable Sync-Check.

BURDEN

Whichever input voltage is high, 11 VA; other input, 1 VA.

CONTROLS

UPPER VOLTAGE LIMIT: 110 to 140 V ac either input, dial calibration accuracy ±2% of full scale.

LOWER VOLTAGE LIMIT: 90 to 120 V ac either input, dial calibration accuracy ±2% of full scale.

DELTA V LIMIT: 1 to 5 V, dial calibration accuracy ±5% of full scale. Other ranges available.

DEAD LINE LIMIT: 10 to 60 V, dial calibration accuracy ±7% of full scale.

DEAD BUS LIMIT: 10 to 60 V, dial calibration accuracy ±7% of full scale.

PHASE ANGLE LIMIT: 0 to ±30°, dial calibration accuracy ±5% of full scale. Other ranges available.

DELTA F LIMIT: 0.01 to 0.5 Hz, dial calibration accuracy ±5% of full scale.

■ **NOTE:** Controls are independent of each other and do not require additional instrumentation for field setting.

LED INDICATORS

All LEDs are lit when conditions are met to close the breaker.

BUS UPPER VOLTAGE LIMIT OK

LINE UPPER VOLTAGE LIMIT OK

BUS LOWER VOLTAGE LIMIT OK

LINE LOWER VOLTAGE LIMIT OK

DELTA V OK

LINE HOT

BUS HOT

ANGLE OK

DELTA F OK

BREAKER CLOSE RELAY

Dry output contacts rated to make and carry 20 A at 250 V dc, and interrupt 0.9 A at 120 V dc or 0.4 A at up to 250 V dc inductive load. Open contacts will withstand 1500 V ac for 1 min. Contacts to ground will withstand 1500 V ac for 1 min.

RESPONSE TIME

When the Line and Bus inputs are first applied to the unit, the voltage magnitude circuits require approximately 0.5 sec. to sense the correct voltage. The unit will simultaneously measure phase angle and close the breaker with proper phase angle after this initial delay. In closing on dead line or dead bus, the phase condition is ignored so that the unit will close upon a voltage below the set threshold in approximately 0.5 sec.

STATUS RELAY CONTACTS

Voltage Status Relay: Closed when Voltage conditions are within limits.

Phase Angle Status Relay: Closed when Phase Angle is within limits.

Delta Frequency Status Relay: Form C contact provided.

These are light duty contacts intended primarily for status interrogation by supervisory. They can be used to light local lights with the following restrictions:

1/2 A at 125 V dc resistive; 1 A at 120 V ac, 250 V dc across open contacts

ANALOG OUTPUTS

Various dc analog outputs are provided for Bus Voltage, Line Voltage, Delta V, Phase Angle, and Delta F. These analog outputs can interface with most SCADA systems.

RELIABILITY

The M-0359 Syncrocloser® Check Plus relay is assembled on three glass-epoxy printed circuit boards. All semiconductor components are hermetically sealed, and of the highest and most reliable quality available. Highly stable, instrument-grade capacitors and resistors are used in critical measurement circuits to minimize the possibility of error.

TRANSIENT PROTECTION

Input and output circuits are protected against system transients. The M-0359 will pass all requirements of ANSI/IEEE C37.90.1-1989, which defines oscillatory and fast transient surge withstand capability. All inputs and outputs will withstand 1500 V ac to chassis or instrument ground for one minute. Voltage inputs are electrically isolated from each other, from other circuits, and from ground.

ENVIRONMENTAL

Temperature Range: Units will operate properly over a temperature range of –40° to +80°C.

Humidity: Stated accuracies are maintained at up to 95% relative humidity (non-condensing).

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

PHYSICAL

Size: 19" wide x 3-1/2" high x 13" deep (48.3 cm x 8.9 cm x 33.0 cm). Requires two rack units space in a standard 19" rack. May also be panel mounted horizontally or vertically.

Approximate Weight: 15 lb (6.8 kg).

Approximate Shipping Weight: 20 lb (9.1 kg).

SYNCROCLOSER® COVER KIT M-0217

The M-0217 may be ordered that includes a transparent cover and mounting bracket to cover the controls and prevent accidental resetting.

PATENT

The M-0359 Syncrocloser Check Plus relay is covered by U.S. Patent 4,218,625.

WARRANTY

The M-0359 Syncrocloser Check Plus relay is covered by a five year warranty from date of shipment.

Specification is subject to change without notice.

BECKWITH ELECTRIC CO., INC.
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ISO 9001:2008

800-0359-SP-MC4 01/13

WARNING

DANGEROUS VOLTAGES, capable of causing death or serious injury, are present on the external terminals and inside the equipment. Use extreme caution and follow all safety rules when handling, testing or adjusting the equipment. However, these internal voltage levels are no greater than the voltages applied to the external terminals.

DANGER! HIGH VOLTAGE

– This sign warns that the area is connected to a dangerous high voltage, and you must never touch it.

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. Qualified personnel should be the only ones who operate and maintain this equipment. Beckwith Electric Co., Inc. assumes no liability for the customer's failure to comply with these requirements.

– This sign means that you should refer to the corresponding section of the operation manual for important information before proceeding.

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 Protective Earth Terminal must be attached to a separate ground securely by use of a tool, since it is not grounded by external connectors.

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 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, & 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.

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 that 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

This unit contains MOS circuitry, which 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

M-0359 Syncrocloser® Check Plus Instruction Book

INTRODUCTION

Please refer to the M–0359 Application Guide in conjunction with this Instruction Book since information contained in one is not usually repeated in the other.

The Beckwith Electric M–0359 Syncrocloser® Check Plus relay uses advanced state-of-the-art semiconductors and circuits to achieve an overall stability and resolution unattainable with current electromechanical sync-check relays. Modern hybrid and monolithic semiconductors using ion implantation and laser trimming are incorporated throughout the Syncrocloser Line to gain temperature stability without critical compensation or trimming.

THEORY OF OPERATION

PHASE ANGLE BOARD AND VOLTAGE BOARD

Refer to Figure 1 Block Diagram. Operating dc voltages are supplied by the power supply section. Input power is driven from either line or bus depending on which is greater in voltage magnitude. Each input (line, bus) is passed through a transformer and scaled down from 120 V ac to 6 V ac. The scaled down voltage is converted to a dc voltage by the ac to dc converter. This converter is an active full-wave rectifier and filter, which eliminates the usual highly temperature-dependent diode drop of conventional full-wave rectifiers. Full-wave rectification was chosen over half-wave rectification because the filter time response is much faster for a given ripple voltage. This is due to the fact that full-wave rectification results in a voltage containing no fundamental frequency components, only harmonics.

Upper and lower voltage comparators compare the output of each ac to dc converter to a portion of a highly stable hybrid 10 V reference. LEDs located on the front panel indicate the condition of each input (line, bus) with reference to upper and lower voltage limits. The dead line/dead bus comparators determine whether either input (line, bus) is below the threshold of the comparator setting. The comparison voltage is the stable 10 V reference, and LEDs indicate each input status.

An absolute value difference amplifier precisely evaluates the difference voltage (Delta V) between the line and bus input, and a comparator compares Delta V to a portion of the stable reference voltage. Again, a front panel LED indicates the status of Delta V. Two zero-crossing detectors generate rectangular waveforms at the zero-crossing of each input. The exclusive OR-gate provides a pulse width proportional to the phase angle between each input. A three-pole active filter provides the required averaging without the excessive time delay of conventional RC filters.

Phase angle voltage varies from 0 to 5 V for a 0° to 180° phase change. A scaling amplifier precisely increases the phase angle voltage (Φ) to provide higher phase angle resolution. The phase angle comparator compares Φ to preset limits. If Φ is within limits, a "close" condition is sent to the logic section. If all voltages and the difference frequency, Delta F, at the inputs are within preset limits, then the output relay is picked up until the phase angle, Delta F or input voltages drop outside the limits.

Dead Line or Dead Bus Closing may be programmed externally, and are functions of the dead line/dead bus logic. The output relay will pick up whenever a dead condition is sensed at the required input, regardless of phase angle, upper and lower voltage limits, Delta V or Delta F. The program may be selected as dead line, dead bus, dead line or dead bus, but **not** dead line and dead bus.

DELTA F BOARD

The phase angle voltage from the Phase Board is input to a second order filter. The filter provides additional averaging to the phase angle voltage. The slope of the phase angle voltage, $d\Phi/dt$, is directly proportional to the difference frequency, Delta F. This derivative is bipolar, depending upon the direction of phase change. By taking the absolute value of $d\Phi/dt$, continuous monitoring of Delta F is achieved without the usual "deadband." Absolute value and time derivative $d\Phi/dt$ are functions of the absolute value amplifier (U1B) and the precision derivative amplifier (U1A). This is followed by a comparator (U2A) which drives a front panel LED indicator and the Delta F status relay.

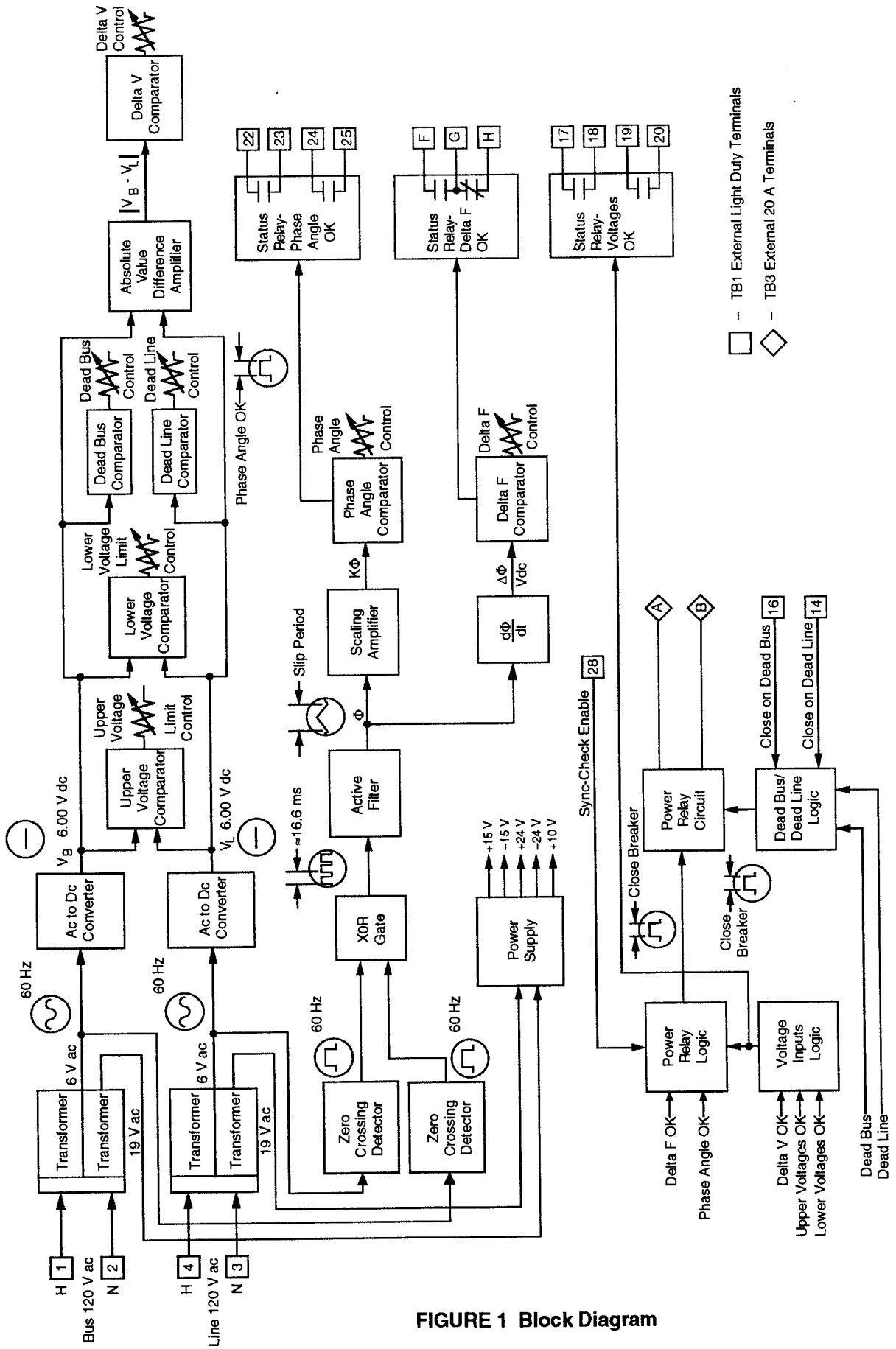


FIGURE 1 Block Diagram

TEST PROCEDURES

TEST SOURCES

Two highly stable test sources must be used to test the M–0359. The power system is suitable as one input for a "general" test, but is not sufficiently stable in phase or frequency to determine the limits of the accuracy of the M–0359.

To properly test the M–0359, each input must have a short-term frequency stability of ±0.001 Hz and phase jitter at no more than 0.1° peak to peak.

EQUIPMENT REQUIRED

1. Two distortion free 60 Hz variable sources, as follows:
   a. A variable frequency, variable phase angle source capable of providing 120 V ac. Maximum phase jitter of 0.1°.
   b. A fixed frequency source capable of providing 120 V ac. Maximum phase jitter of 0.1°.
2. Two digital multimeters with ac and dc accuracy of 0.2% of full-scale ±1 least significant digit; Hewlett-Packard 3465A or equivalent.
3. A solder sucking syringe or solder wick.
4. A soldering iron - Weller Controlled Output Soldering Station, model MTCPL, 60 W, 120 V, 50/60 Hz or equivalent.
5. A stopwatch or any accurate timing device.

COMPONENT REPLACEMENT PROCEDURE

1. To gain access to the circuit board, remove the top and bottom covers of the unit. Components can now be easily tested or changed. Analysis of the circuit will then often lead to the cause of the failure and components to be replaced.
2. If a component needs to be changed, carefully scrape away the coating surrounding the component using a small, sharp knife, being careful not to damage the printed circuit path.
3. Clip out the old component and discard.
4. Remove the clipped wires using the solder wick or syringe. Be sure to leave the holes clear to facilitate insertion of the new component.

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

5. When replacing integrated circuits, be sure to insert the unit into the transipad so that the tab fits into the slot. Once this is done, there is only one way to insert the combination into the printed circuit board.

TEST PROCEDURE

Refer to Figure 2 External Connections, Figure 5 Phase Board Component Location, Figure 6 Voltage Board Component Location, and Figure 7 Delta F Board Component Location.

UPPER VOLTAGE LIMIT

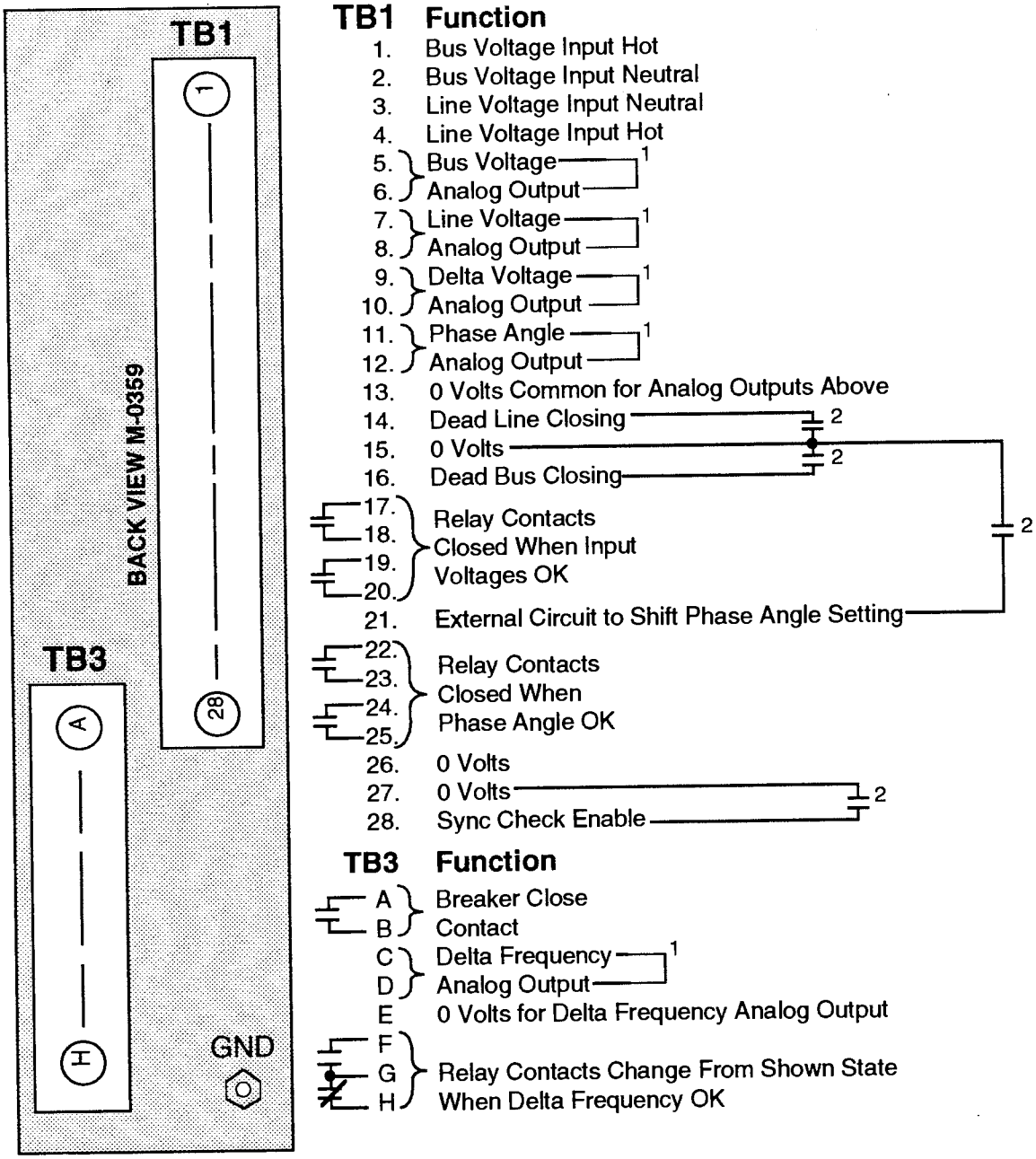
1. Set the **UPPER VOLTAGE LIMIT** control at 125 V.
2. Supply 120 V ac, 60 Hz to the Bus input TB1-1 and TB1-2, noting that TB1-1 is the HOT terminal.
3. Supply 120 V ac, 60 Hz to the Line input TB1-3 and TB1-4, noting that TB1-4 is the HOT terminal.
4. Slowly increase the Bus input until the **UPPER VOLTAGE LIMIT BUS OK** LED turns off. The LED should turn off at 125 V ±2.8 V.
5. Decrease the Bus input to 120 V.
6. Slowly increase the Line input until the **UPPER VOLTAGE LIMIT LINE OK** LED turns off. The LED should turn off at 125 V ±2.8 V.
7. Decrease the Line input to 120 V.

LOWER VOLTAGE LIMIT

1. Set the **LOWER VOLTAGE LIMIT** control at 105 V.
2. Supply 120 V ac, 60 Hz to the Bus input TB1-1 and TB1-2, noting that TB1-1 is the HOT terminal.
3. Supply 120 V ac, 60 Hz to the Line input TB1-3 and TB1-4, noting that TB1-4 is the HOT terminal.
4. Slowly decrease the Bus input until the **LOWER VOLTAGE LIMIT BUS OK** LED turns off. The LED should turn off at 105 ±2.4 V.
5. Increase the Bus input to 120 V.
6. Slowly decrease the Line input until the **LOWER VOLTAGE LIMIT LINE OK** LED turns off. The LED should turn off at 105 ±2.4 V.
7. Increase the Line input to 120 V.

DELTA V LIMIT

1. Set the **DELTA V LIMIT** control at midscale.
2. Supply 110 V ac, 60 Hz to the Bus input TB1-1 and TB1-2, noting that TB1-1 is the HOT terminal.



■ **NOTES:**

1. External connections are shown for voltage output and current output in Figures 3 and 4 of the Application Guide.
2. Close the external circuit to enable the function. These inputs should <u>not</u> be permanently jumpered, since an inadvertent close command can take place if a voltage transformer or it's associated circuit fails open.
3. Close the external circuit to enable the function. If a function is required at all times, permanent enable jumpers may be added.

FIGURE 2 External Connections

3. Supply 110 V ac, 60 Hz to the Line input TB1-3 and TB1-4, noting that TB1-4 is the HOT terminal.

4. Slowly increase the line input voltage until the **DELTA V LIMIT OK** LED turns off. The LED should turn off at 1/2 the scale setting ±5% of full scale.

   Example: With a **DELTA V LIMIT** full scale range of 10 V, the midscale value would be 5 V. Therefore, the LED should turn off at 5 V ±0.5 V (voltage difference).

DEAD LINE LIMIT

1. Place a jumper between TB1–14 and TB1–15.

2. Adjust the **DEAD LINE LIMIT** control to 40 V.

3. Slowly reduce the Line voltage. The output Breaker Close Relay should pick up as the Line voltage goes below 40 V. The **DEAD LINE LIMIT OK** LED should extinguish at the same time.

4. Return the Line voltage to 120 V ac.

DEAD BUS LIMIT

1. Place a jumper between TB1–15 and TB1–16.

2. Adjust the **DEAD BUS LIMIT** control to 40 V.

3. Slowly reduce the Bus voltage. The output Breaker Close Relay should pick up as the Bus voltage goes below 40 V. The **DEAD BUS LIMIT OK** LED should extinguish at the same time.

4. Return the Bus voltage to 120 V ac.

PHASE ANGLE LIMIT

1. Adjust the **PHASE ANGLE LIMIT** control to midscale.

2. Slowly adjust the phase difference between the Line and Bus to midscale (15°, 30° or 45° depending on the scale selected). The **PHASE ANGLE LIMIT OK** LED will extinguish as the midscale angle is passed.

DELTA F LIMIT

1. Adjust the **DELTA F LIMIT** control to 0.25 Hz.

2. Adjust the Line and Bus voltages to 120 V ac with a phase difference of 15°.

3. Adjust the **DELTA V LIMIT** control, **PHASE ANGLE LIMIT** control, and **UPPER VOLTAGE LIMIT** control fully clockwise.

4. Adjust the **LOWER VOLTAGE LIMIT** control fully counter-clockwise.

5. Slowly adjust the frequency difference between the Line and Bus.

6. The **DELTA F LIMIT OK** LED should extinguish as the frequency difference passes ±0.25 Hz ±.025 Hz.

TYPICAL VOLTAGES

■ **NOTE:** Points are on the Phase Board, unless noted.

FROM	TO	CONDITION	VOLTAGE
D44 (Cathode)	D45 (Cathode)	120 V ac Input to Bus	40 V ac
D49 (Cathode)	D48 (Cathode)	120 V ac Input to Line	40 V ac
TP6	TP1	120 V ac on Line or Bus	+24 V dc
TP6	TP3	120 V ac on Line or Bus	–24 V dc
TP6	TP4	120 V ac on Line or Bus	–15 V dc
TP6	TP2	120 V ac on Line or Bus	+15 V dc
TP6	TP5	120 V ac on Line or Bus	+10 V dc
TP6	U5 - Pin 13	120 V ac on Line or Bus	+7.5 V dc approx.
TP6	U5 - Pin 9	120 V ac on Line or Bus	+7.5 V dc approx.
TP6	TP11	100 V ac on Line and Bus 0° Phase Shift	0 V
TP6	TP11	50 V ac on Line or Bus	+10 V dc
TP6	T2-4	120 V ac on Line	6 V ac
TP6	T1-4	120 V ac on Bus	6 V ac
TP6	TP6*	120 V ac on Bus	+6 V dc
TP6	U2 - Pin 13*	120 V ac on Line or Bus	+5.25 V dc ±14.5%
TP6	TP2*	120 V ac on Line or Bus	±14 V dc
TP6	TP7*	120 V ac on Line	+6 V dc
TP6	U2 - Pin 9*	120 V ac on Line or Bus	+5.25 V dc ±14.5%
TP6	TP1*	120 V ac on Line or Bus	±14 V dc
TP6	TP6*	120 V ac on Bus	+6 V dc
TP6	U2 - Pin 2*	120 V ac on Line or Bus	+6.25 V dc ±12%
TP6	TP5*	120 V ac on Line or Bus	±14 V dc
TP6	U2 - Pin 5*	120 V ac on Line or Bus	+6.25 V dc ±12%
TP6	TP7*	120 V ac on Line	+6 V dc
TP6	TP4*	120 V ac on Line or Bus	±14 V dc
TP6	TP8	Line and Bus Inputs 180° out of phase	+10 V dc
TP6	TP8	Line and Bus Inputs in phase	0 V

* On Voltage Board

FROM	TO	CONDITION	VOLTAGE
TP6	TP7	Line and Bus Inputs 180° out of phase	±14 V dc
TP6	TP7	Line and Bus Inputs in phase	0 V
TP6	U6 - Pin 14	120 V ac on Line or Bus	2 V ±2 approx.
TP6	U6 - Pin 1	120 V ac on Line or Bus	6 V ±6 approx.
TP6	U7 - Pin 13	120 V ac on Line and Bus when timer times out	+15 V approx.
TP6	U7 - Pin 12	120 V ac on Line and Bus Both inputs in phase.	+15 V approx.
TP6	U6 - Pin 12*	120 V ac on Line or Bus	+1.75 V dc ±72% approx.
TP6	TP7*	120 V ac on Line	+6 V dc
TP6	U6 - Pin 14*	120 V ac on Line or Bus	1 or 13 V dc
TP6	TP6*	120 V ac on Bus	+6 V dc
TP6	U10 - Pin 3*	120 V ac on Line or Bus	+1.75 V dc ±72% approx.
TP6	U10 - Pin 6*	120 V ac on Line or Bus	±13 V dc
TP6	D15 Anode	All LEDs lit on front panel	+1.5 V
TP6	TP3*	Line 120 V ac Bus 115 V ac Delta V Range 1 - 5	+2.5 V
TP6	U5 - Pin 6*	120 V ac on Line or Bus	±13 V dc
TP6	U5 - Pin 3*	120 V ac on Line or Bus	+6 V ±67%
TP6	TP1**	Line and Bus Input Frequency Difference 0.5 Hz	+10 V dc

* On Voltage Board

** On Delta F Board

▲ **CAUTION: Any attempt to measure resistance between points on the printed circuit board is likely to cause damage to the unit.**

CALIBRATION

■ NOTE: The M–0359 unit has been fully calibrated at the factory using highly sophisticated, computer-controlled test equipment. There is no need to re-calibrate the units before initial installation. Further calibration is only necessary if a component was changed during a repair procedure. If calibration becomes necessary, it should be performed before mounting the M–0359 in a rack, since the top cover of the unit must be removed to reach calibration points. Refer to Figure 2 External Connections, Figure 3 Phase Board Component Location for Calibration and Range Resistors and Figure 4 Voltage Board Component Location for Calibration and Range Resistors.

AC TO DC CONVERTER

The ac to dc converter consists of quad op amp U1 with potentiometers R1, R2, R23 and R24 providing calibration for the Line and Bus inputs.

1. Supply 120 V ac, 60 Hz to Bus input TB1-1 and TB1-2, noting that TB1-1 is the HOT terminal.
2. Continuously monitor the Bus input to assure that the 120 V ac supply remains steady.
3. Place the positive lead of the dc voltmeter on Test Point 7 on the Voltage Board.
4. Place the negative lead on Test Point 6 on the Phase Board.
5. Adjust potentiometer R24 (Line Offset Trimmer) to read 0.00 V dc.
6. Disconnect power to the Bus input TB1-1 and TB1-2.
7. Supply 120 V ac, 60 Hz to the Line input TB1-3 and TB1-4, noting that TB1-4 is the HOT terminal.
8. Place the positive lead of the dc voltmeter on Test Point 6 on the Voltage Board.
9. Place the negative lead on Test Point 6 on the Phase Board.
10. Adjust potentiometer R2 (Bus Offset Trimmer) to read 0.00 V dc.
11. Supply 120 V ac, 60 Hz to Bus input TB1-1 and TB1-2, noting that TB1-1 is the HOT terminal.
12. Continuously monitor the Bus input to assure that the 120 V ac supply remains steady.
13. Increase the Line input to 130 V ac.
14. Adjust potentiometer R1 (Bus Voltage Trimmer) to read 6.00 V dc.
15. Decrease the Bus input to 100 V ac; the dc voltmeter should read 5.00 V dc.
16. Increase the Bus input to 130 V ac.
17. Decrease the Line input to 120 V ac.

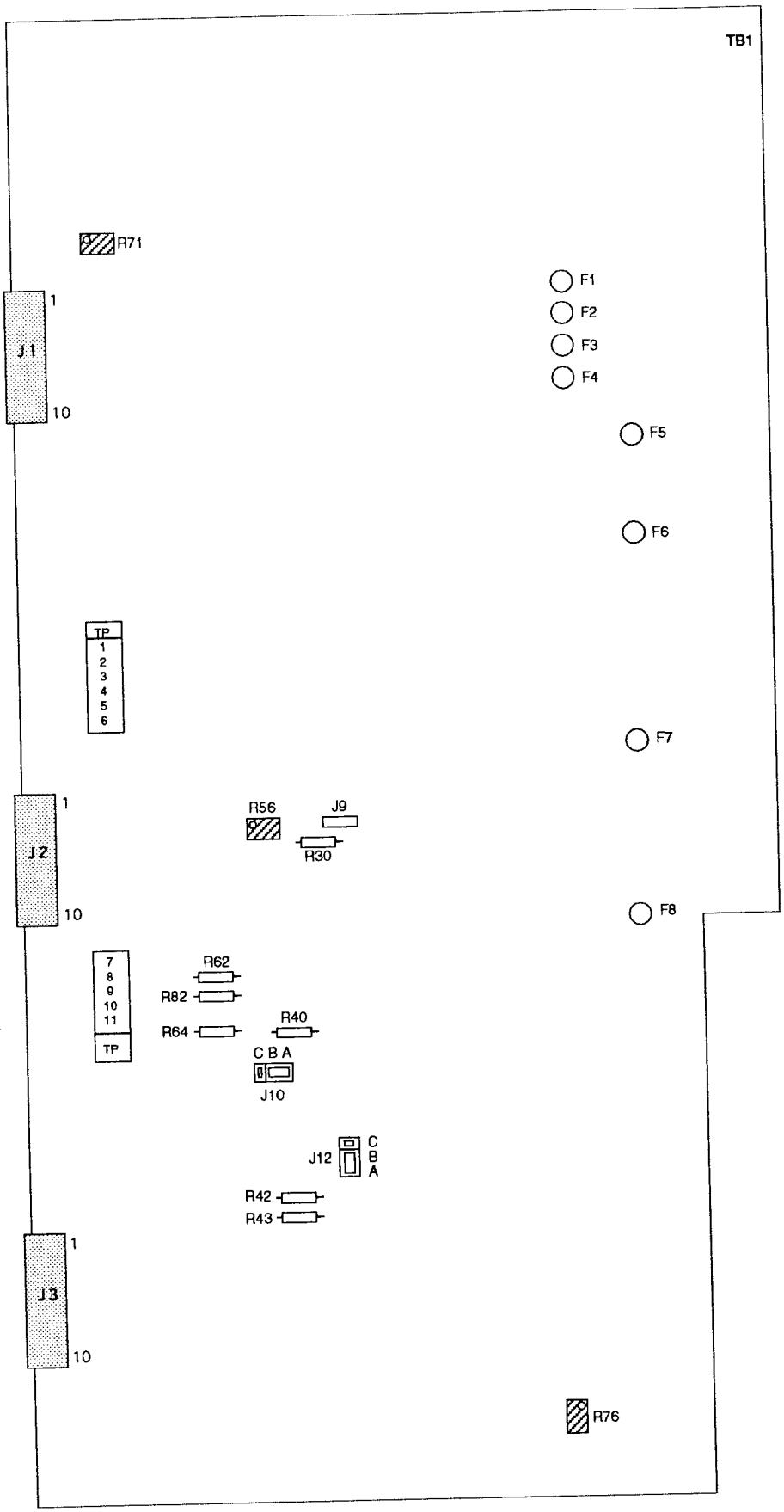


FIGURE 3 Phase Board Component Location for Calibration and Range Resistors

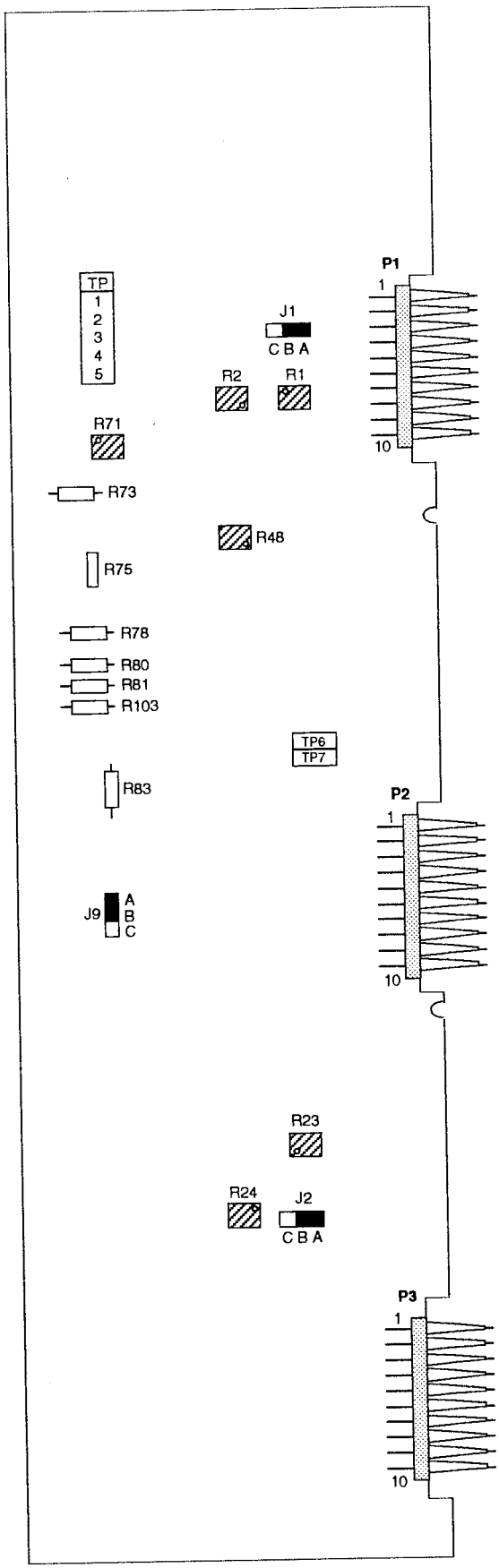


FIGURE 4 Voltage Board Component Location for Calibration and Range Resistors

18. Continuously monitor the Line input to assure that the 120 V ac supply remains steady.
19. Place the positive lead of the dc voltmeter on Test Point 7 on the Voltage Board.
20. Place the negative lead on Test Point 6 on the Phase Board.
21. Adjust potentiometer R23 (Line Voltage Trimmer) to read 6.00 V dc.
22. Decrease the Line input to 100 V ac; the dc voltmeter should read 5.00 V dc.

ABSOLUTE VALUE DIFFERENCE AMPLIFIER

Components U3, U4, and U11 form this circuit on the Voltage Board.

1. Supply 120.0 V to TB1-1 and TB1-2, noting that TB1-1 is the HOT terminal.
2. Supply 120.0 V to TB1-3 and TB1-4, noting that TB1-4 is the HOT terminal.
3. Place the positive lead of the dc voltmeter on Test Point 3 on the Voltage Board.
4. Place the negative lead on Test Point 6 on the Phase Board.
5. Adjust potentiometer R71 (Delta V Offset Trimmer) to read 0.001 V dc.
6. Supply voltage to the Bus and Line input terminals according to the values in Table 1.
9. Continuously monitor the voltage to ensure that they remain steady.
10. Place the positive lead of the dc voltmeter on Test Point 3 on the Voltage Board.
11. Place the negative lead on the Test Point 6 on the Phase Board.
12. Adjust potentiometer R48 (Delta V Trimmer) on the Voltage Board to read the voltage indicated in Table 1.

Delta V Range	Bus Input TB1–1 (HOT) TB1–2 (NEUTRAL)	Line Input TB1–3 (NEUTRAL) TB1–4 (HOT)	Voltmeter Reading
1 - 5	115 V ac	120 V ac	2.50 V dc
2 - 10	110 V ac	120 V ac	5.00 V dc
3 - 15	110 V ac	125 V ac	7.50 V dc
4 - 20	110 V ac	130 V ac	10.00 V dc
5 - 25	105 V ac	130 V ac	2.50 V dc
6 - 30	105 V ac	135 V ac	2.25 V dc
10 - 50	90 V ac	140 V ac	10.00 V dc

TABLE 1 Delta V Calibration

PHASE ANGLE

1. Place a clip lead between TB1–1 and TB1–4.
2. Place a second clip lead between TB1–2 and TB1–3.
3. Supply 120 V ac, 60 Hz to Bus inputs TB1–1 and TB1–2, noting that TB1–1 is the HOT terminal.
4. Attach the positive lead of the dc voltmeter to Test Point 11 on the Phase Board.
5. Attach the negative lead to Test Point 6 on the Phase Board.
6. Adjust R71 (Phase Angle Trimmer) to obtain the lowest possible voltage reading (less than 1 mV dc).
7. Move the positive test lead of the dc voltmeter to Test Point 7 on the Phase Board.
8. Adjust R76, (Phase Angle Offset Trimmer) until the voltmeter reads 0 V dc ±0.020 V.

DELTA F

The Delta F function consists of components U1 and U2 on the Delta F Board.

1. Set the front panel **DELTA F LIMIT** control to 0.3 Hz.
2. Place a clip lead between TB1-1 and TB1-4.
3. Place a second clip lead between TB1-2 and TB1-3.
4. Provide 120 V ac to the Bus inputs TB1-1 and TB1-2, noting that TB1-1 is the HOT terminal.
5. Attach the positive lead of the voltmeter to TP1 on the Delta F Board.
6. Attach the negative lead to Test Point 6 on the Phase Board.
7. Adjust R10 to get the lowest possible reading (less than 1 mV dc).
8. Remove the clips, and supply 118 V to the Line inputs at 60.500 Hz.
9. Adjust R11 to get 10.000 V dc.
10. Attach a 1.00 K ±1% resistor from TB3-D to TB3-E.
11. Place a current measuring device from TB3-C to TB3-D.
12. Adjust R21 to get 1.00 mA ±0.05 mA.

HOW TO CHANGE RANGES

1. Follow steps 1 through 5 in the **COMPONENT REPLACEMENT PROCEDURE** section using the equipment specified.

2. Referring to the tables below and to the **SELECTED RESISTORS** section of the **PARTS LIST**, choose the correct resistor value or jumper wire. Use 20 gauge insulated wire for all jumpers. Refer to Figures 6 and 7 for the location of these parts.

3. Refer to the **CALIBRATION** section after replacing any components.

DELTA V LIMIT (VOLTAGE BOARD)

								Phase
	R81	R48	R73	R80	R78	R50	R103	R20
1-5	11 K	50 K	182 K	open	open	180 K	open	1.13 K
2 - 10	11 K	50 K	182 K	5.62 K	open	180 K	open	1.13 K
3 - 15	11 K	50 K	182 K	5.62 K	1.87 K	180 K	open	1.13 K
4 - 20	11 K	50 K	182 K	5.62 K	1.87 K	180 K	jumper	1.13 K
5 - 25	11 K	10 K	35.7 K	open	open	180 K	open	6.81 K
6 - 30	11 K	10 K	24.9 K	open	open	180 K	open	6.81 K
10 - 50	Open	20 K	71.5 K	open	open	91 K	jumper	1.13 K

PHASE ANGLE LIMIT PHASE BOARD

Range	R62	R64	R82
30°	16.5 K	12.7 K	Open
45°	16.5 K	Open	Open
60°	48.7 K	Open	Open
90°	10.0 K	Open	0 Ω

PHASE LIMIT REDUCTION RATIO PHASE BOARD

Nominal Value	R40*	J10**
1/1.5	5.90 K	B&C
1/2	3.01 K	B&C
1/4	1.0 K	B&C
1/5	750 Ω	B&C
4/5	12.1 K	B&C
None		A&B

* ■ **NOTE:** Selected at Pretest.

** Two-positionshunt on the phase board.

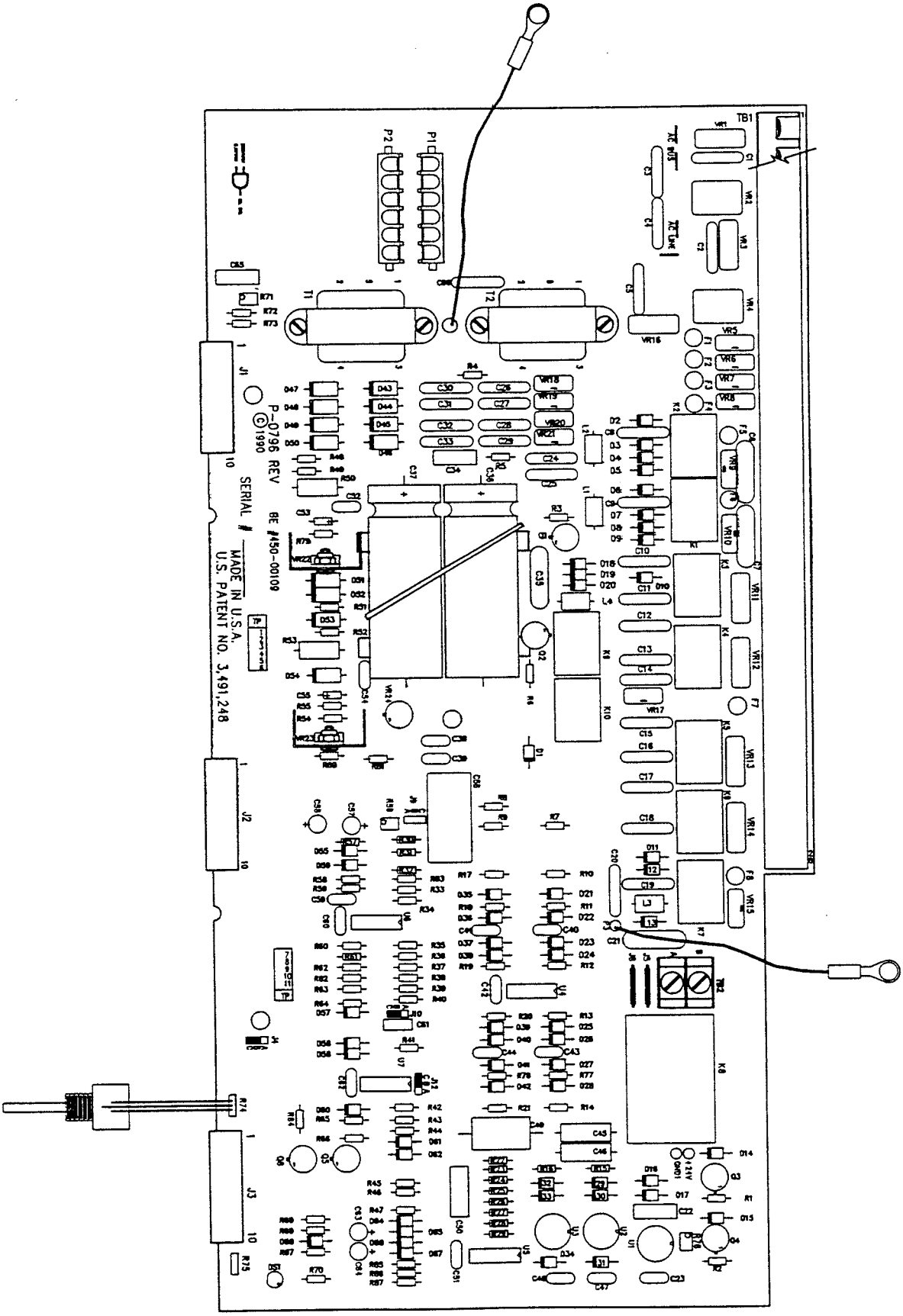


FIGURE 5 Phase Board Component Location

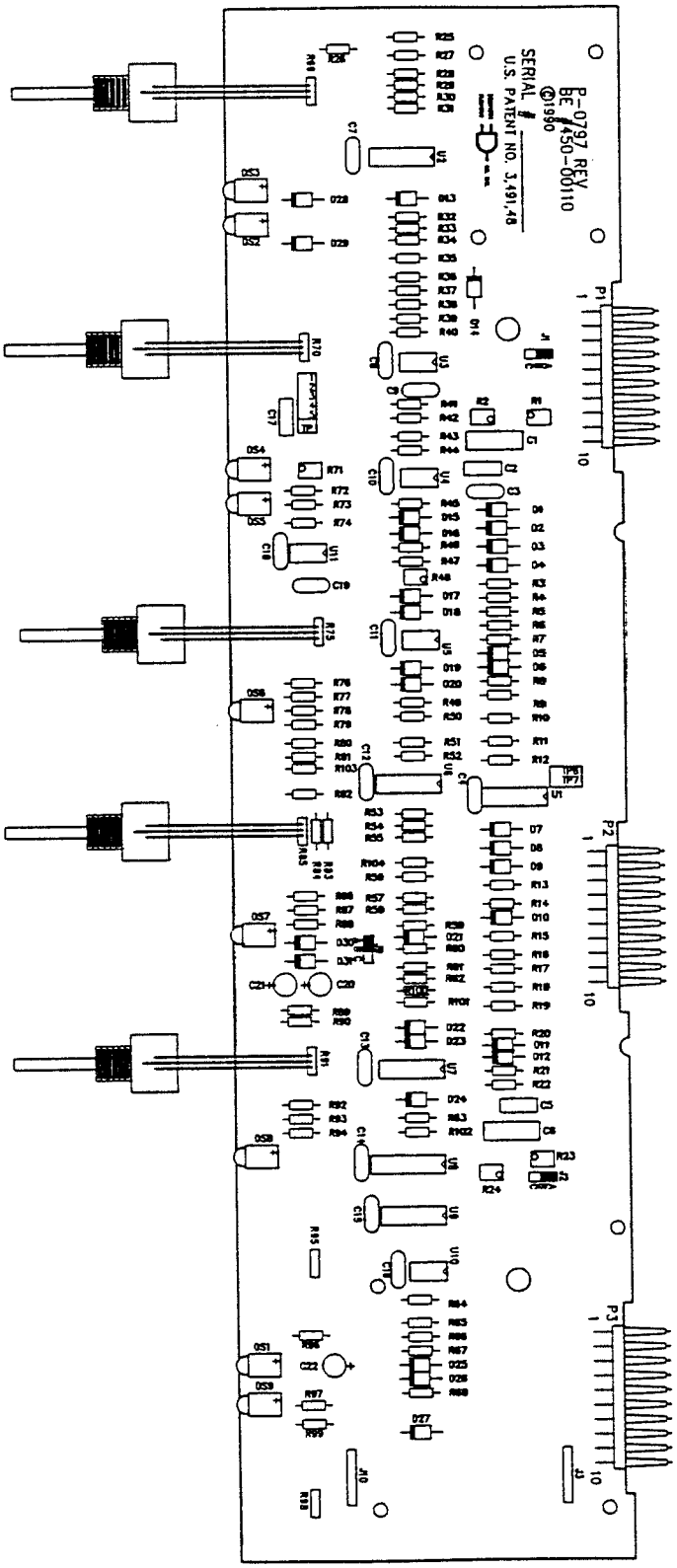


FIGURE 6 Voltage Board Component Location

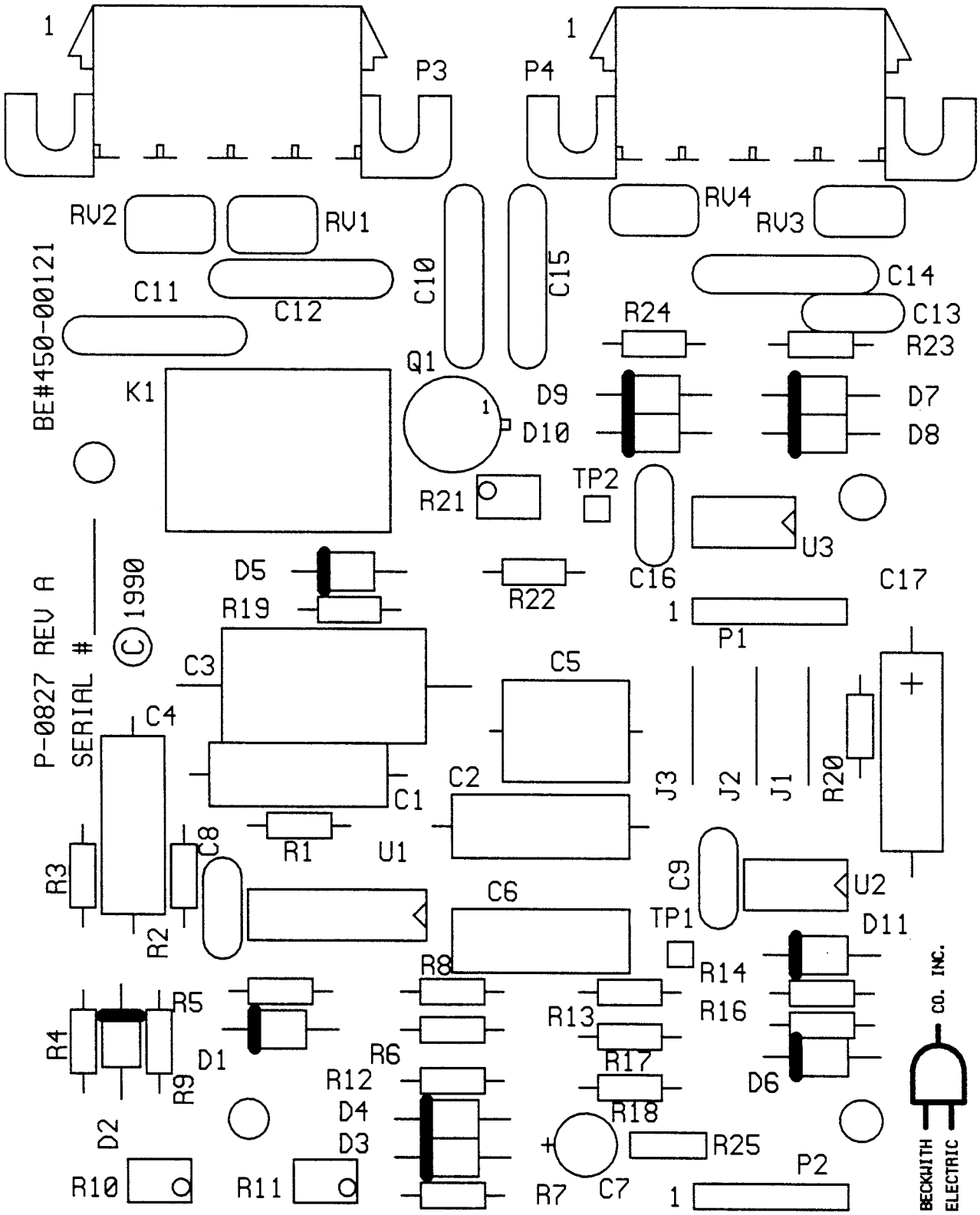


FIGURE 7 Delta F Board Component Location

PARTS LIST

M-0359 Syncrocloser® Check Plus

This list includes all electrical and mechanical parts which could conceivably either require replacement or be lost. The **COMPONENT DESIGNATION** is the same as that appearing on schematics or referred to in Instruction Books.

The **BECO NUMBER** refers to an index maintained by the company. This lists the currently available device which may be substituted even though the device originally supplied is obsolete and no longer available. Parts marked by an asterisk* are not available from other sources. Either the original component or a current substitute will be carried in stock by Beckwith Electric.

Parts not marked with an asterisk are normally available from an electronics components house. Those parts or a current substitute will normally be available from Beckwith Electric stock.

In either case, when parts are ordered from Beckwith Electric, we will be responsible for supplying the current replacement in the shortest possible time.

Sufficient detailed description is also given to permit purchasing from an electronics parts house, providing the part is of equal or better quality to insure reliable operation. This may require some interpretation of specifications which may be avoided by direct purchase from Beckwith Electric using the **BECO NUMBER**.

Note that in a few instances, components are selected in final test. Procedures described in the **TEST PROCEDURES** section must be followed in replacing these components.

All resistors are 1/2 W unless noted.

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
PHASE BOARD, B-0381		
	450-00109*	Printed Circuit Board, P-0796
C1,C2	000-00904	Capacitor, Ceramic Disk, 0.01 µF ±20%, 1 kV
C3-C5, C8-C20, C24-C33, C66	000-00939	Capacitor, Ceramic Disk, 0.0047 µF ±20%, 3 kV
C6, C7, C21, C35	000-00905	Capacitor, Ceramic Disk, 0.05 µF +80/-20%, 600 V
C22	000-00845	Capacitor, Polyester, 0.068 µF ±10%, 250 V
C23, C40-C44, C47, C48, C51, C52, C54, C60, C62	000-00917	Capacitor, Ceramic Disk, 0.01 µF ±20%, 50 V
C34, C65	000-00811	Capacitor, Polyester, 0.1 µF ±10%, 100 V
C36, C37	000-00410	Capacitor, Electrolytic, 1900 µF +75/-10%, 50 V

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
C38,C39,C59	000-00932	Capacitor, Ceramic Disk, 0.1 µF ±20%, 50 V
C45,C46	010-00420	Capacitor, Polycarbonate, 0.022 µF ±10%, 50 V
C49	000-00705	Capacitor, Polyester, 0.27 µF ±10%, 50 V
C50	000-00843	Capacitor, Polyester, 0.39 µF ±5%, 100 V
C53,C55	000-00505	Capacitor, Tantalum, 1 µF ±10%, 50 V
C56	000-00847	Capacitor, Polyester, 10 µF ±10%, 63 V
C57	000-00553	Capacitor, Tantalum, 2.2 µF ±10%, 25 V
C58	0000-00018	Capacitor, Electrolytic, 1.5 µF ±20%, 50 V
C61	000-00934	Capacitor, Ceramic Disk, 0.0047 µF ±10%, 50 V
C63, C64	000-00559	Capacitor, Tantalum, 6.8 µ ± 20% 50 V
D1,D10,D16,D17,D21, D22-D42,D55,D57-D61, D66-D68	400-00224	Diode, 1N4148
D2,D3,D5-D7,D9,D11, D12,D14,D19,D20,D56,	400-00211	Diode, 1N5061
D4,D8,D13,D18	400-00061	Diode, Zener, 36 V ±5%, 1N5365B
D15	400-00004	Diode, Zener, 10 V ±5%, 1N758A
D43-D50,D52,D53	400-00213	Diode, 1N5626
D51,D54	400-00095	Diode, 43 V, 1N5367B
D62,D64,D65	400-00225	Diode, FHD333
D63		Not Used
F1-F8	420-00725	Fuse, Plug-In, 1/2 A, 125 V, Littelfuse 273.500
FH1-FH8	420-00722	Fuse Holder, Plug-In, Vertical
J1-J3	420-00286	Socket, Right Angle, 10-Position, 0.156 Center
J4,J10,J12	420-00232	Header, 36-Position, 0.1 Center

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
J5-J8,J9,J11		Not Used
K1-K7,K9,K10	430-00151	Relay, SPDT, 24 V dc, American Zettler AZ4UP-E-1C-24D
K8	430-00144	Relay, 4PDT, 24 V dc
L1-L4	410-00521	Choke, 180 MHz
P1,P2	030-00040	Header, 6-Position, AMP 641832-1
Q1-Q6	400-00300	Transistor, 2N1711
R1	180-00271	Resistor, Carbon Comp, 270 Ω ±5%, 1/4 W
R2	180-00222	Resistor, Carbon Comp, 2.2 K ±5%, 1/4 W
R3,R6,R47,R57,R87	180-00103	Resistor, Carbon Comp, 10 K ±5%, 1/4 W
R4	330-00518	Resistor, Metal Film, 15.0 K ±1%, 1/4 W
R5,R73	330-00469	Resistor, Metal Film, 5.11 K ±1%, 1/4 W
R7,R8	330-00579	Resistor, Metal Film, 64.9 K ±1%, 1/4 W
R9,R29	330-00502	Resistor, Metal Film, 10.2 K ±1%, 1/4 W
R10,R14,R18,R21	330-00566	Resistor, Metal Film, 47.5 K ±1%, 1/4 W
R11,R17,R77,R78	330-00401	Resistor, Metal Film, 1 K ±1%, 1/4 W
R12,R20	330-00406	Resistor, Metal Film, 1.13 K ±1%, 1/4 W
R13,R19,R29	330-00501	Resistor, Metal Film, 10.0 K ±1%, 1/4 W
R15,R16,R67-R69	180-00203	Resistor, Carbon Comp, 20 K ±5%, 1/4 W
R22,R23,R28	330-00602	Resistor, Metal Film, 102 K ±1%, 1/4 W
R24,R25,R33,R34,R66	180-00104	Resistor, Carbon Comp, 100 K ±5%, 1/4 W
R26,R27	180-00473	Resistor, Carbon Comp, 47 K ±5%, 1/4 W
R30		Not Used
R31	330-00385	Resistor, Metal Film, 750 Ω ±1%, 1/4 W

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
R32,R38	330-00473	Resistor, Metal Film, 5.62 K ±1%, 1/4 W
R35,R51,R52	180-00102	Resistor, Carbon Comp, 1 K ±5%, 1/4 W
R36	180-00244	Resistor, Carbon Comp, 240 K ±5%, 1/4 W
R37	330-00485	Resistor, Metal Film, 7.5 K ±1%, 1/4 W
R39	330-00270	Resistor, Metal Film, 52.3 Ω ±1%, 1/4W
R40	330-00447	Resistor, Metal Film, 3.01 K ±1%, 1/4 W
R41,R65	180-00273	Resistor, Carbon Comp, 27 K ±5%, 1/4 W
R42		Not Used
R43	330-00605	Resistor, Metal Film, 110 K ±1%, 1/4 W
R44	180-00101	Resistor, Carbon Comp, 100 Ω ±5%, 1/4 W
R45,R46	180-00393	Resistor, Carbon Comp, 39 K ±5%, 1/4 W
R48,R54	330-00414	Resistor, Metal Film, 1.37 K ±1%, 1/4 W
R49,R55	330-00310	Resistor, Metal Film, 124 Ω ±1%, 1/4 W
R50,R53	370-00010	Resistor, Wirewound, 4.7 Ω ±5%, 2 W
R56	360-00130	Potentiometer, 2 K ±10%, 1/4 W, Bourns 3266W-1-202
R58	180-00200	Resistor, Carbon Comp, 20 Ω ±5%, 1/4 W
R59	180-00513	Resistor, Carbon Comp, 51 K ±5%, 1/4 W
R60,R61,R72	330-00501	Resistor, Metal Film, 10 K ±1%, 1/4 W
R62	330-00522	Resistor, Metal Film, 16.5 K ±1%, 1/4 W
R63	330-00481	Resistor, Metal Film, 6.81 K ±1%, 1/4 W
R64	330-00511	Resistor, Metal Film, 12.7 K ±1%, 1/4 W
R70		Not Used
R71	360-00140	Potentiometer, 10 K ±10%, 12-Turn, Bourns 3266W-1-103
R74	360-00119	Potentiometer, Cermet, 50 K ±10%, Allen-Bradley 73B1G040S503W
R75		Not Used
R76	360-00141	Potentiometer, 20 K ±10%, 12-Turn, 1/4 W, Bourns 3266W-1-203

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
R79-R81,R83	370-00020	Resistor, 0 Ω (Jumper)
R82,R84		Not Used
R85,R86	180-00913	Resistor, Carbon Comp, 91 K, 15%, 1/4 W
T1,T2	410-00031*	Transformer, Input, U-0086
TB1	420-00052	Terminal Block, Right Angle, 28-Position, R.D.I. 6PCR-28-001
TB2	420-00066	Terminal Block, 2-Position, Curtis CBP-2C
TB3	420-00232	Terminal Block, 8-Position, TRW 14ZY-355-18-08-001
TP1-TP11	420-00232	Header, 36-Position, 0.1 Centers
U1-U3	400-00620	Op Amp, LF255H
U4,U6	400-00639	Quad Op Amp, Fairchild μA4136DM
U5	400-00670	Quad Gate, Exclusive OR, Motorola MC-14070BCL/BAL
U7	400-00636	Quad AND-Gate, MC14081
VR1,VR3,VR11-VR14, VR16	400-00724	Varistor, 250 V
VR2,VR4	400-00718	Varistor, 1 kV
VR5-VR10,VR15, VR17-VR21	400-00713	Varistor, 40 V
VR22	560-00008	Voltage Regulator, Adjustable, LM317T
VR23	560-00010	Voltage Regulator, Adjustable, LM337T
VR24	400-00644	Voltage Reference, National LH0070-1H

REV A

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
		VOLTAGE BOARD, B-0382
	450-00110*	Printed Circuit Board, P-0797
C1,C6	000-00841	Capacitor, Polycarbonate, 0.18 µF ±5%, 100 V
C2,C5	000-00842	Capacitor, Polycarbonate, 0.68 µF ±5%, 250 V
C3,C9,C19	000-00903	Capacitor, Ceramic Disk, 100 pF ±10%, 1 kV
C4,C7,C8,C10-C16,C18	000-00917	Capacitor, Ceramic Disk, 0.01 µF ±20%, 50 V
C17	010-00445	Capacitor, Polycarbonate, 0.1 µF ±10%, 100 V
C20-C22	000-00555	Capacitor, Tantalum, 4.7 µF ±20%, 25 V
D1-D4,D7-D10,D13-D16, D27	400-00225	Diode, Fairchild FHD333
D5,D6,D11,D12,D17-D25, D28-D31	400-00224	Diode, 1N4148
D26	400-00239	Diode, Schottky, Hewlett-Packard 5082-2810
DS1-DS9	400-00729	LED, Red, Right Angle PC Mount, IDI
J1,J2,J9	420-00232	Header, 36-Position, 0.1 Centers
J3,J10	420-00315	Socket Strip, 6-Position, 0.1 Centers
J4-J8		Not Used
P1-P3	420-00287	Header, Right Angle, 10-Position, 0.156 Centers, Molex 26-48-2106 Series 41672
R1,R23	360-00140	Potentiometer, 10 K ±10%, 12-Turn, Bourns 3266W-1-103
R2,R24,R71	360-00141	Potentiometer, 20 K ±10%, 12-Turn, Bourns 3266W-1-203
R3,R4,R11,R13,R14,R22	330-00568	Resistor, Metal Film, 49.9 K ±1%, 1/4 W
R5-R8,R15,R16,R20,R21	330-00601	Resistor, Metal Film, 100 K ±1%, 1/4 W

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
R9,R17,R51-R53,R72	330-00701	Resistor, Metal Film, 1 M ±1%, 1/4 W
R10,R18,R49,R57,R58, R74,R92	330-00401	Resistor, Metal Film, 1 K ±1%, 1/4 W
R12,R19	330-00589	Resistor, Metal Film, 82.5 K ±1%, 1/4 W
R25,R39,R54	330-00501	Resistor, Metal Film, 10 K ±1%, 1/4 W
R26	330-00526	Resistor, Metal Film, 18.2 K ±1%, 1/4 W
R27,R38,R80,R83,R94	330-00473	Resistor, Metal Film, 5.62 K ±1%, 1/4 W
R28,R30,R33,R34	180-00395	Resistor, Carbon Comp, 3.9 M ±5%, 1/4 W
R29,R31,R32,R35,R65, R79,R97	180-00622	Resistor, Carbon Comp, 6.2 K ±5%, 1/4 W
R36	330-00513	Resistor, Metal Film, 13.3 K ±1%, 1/4 W
R37	330-00518	Resistor, Metal Film, 15 K ±1%, 1/4 W
R40-R46	340-00002	Resistor, 20 K ±0.1%, 1/4 W
R47	340-00001	Resistor, 10 K ±0.1%, 1/4 W
R48	360-00142	Potentiometer, 12-Turn, Top Adjust, 50 K ±10%, 1/4 W, Bourns 3266W-1-503
R50	180-00184	Resistor, Carbon Comp, 180 K ±5%, 1/4 W
R55	330-00454	Resistor, Metal Film, 3.57 K ±1%, 1/4 W
R56,R99	180-00302	Resistor, Carbon Comp, 3.0 K ±5%, 1/4 W
R59-R63,R89,R90	180-00104	Resistor, Carbon Comp, 100 K ±5%, 1/4 W
R87	180-00304	Resistor, Carbon Comp, 300 K ±5%, 1/4 W
R60-R63,R89,R90	180-00104	Resistor, Carbon Comp, 100 K ±5%, 1/4 W
R64,R84,R86,R96	180-00105	Resistor, Carbon Comp, 1 M ±5%, 1/4 W
R66,R88	180-00103	Resistor, Carbon Comp, 10 K ±5%, 1/4 W
R67	180-00204	Resistor, Carbon Comp, 200 K ±5%, 1/4 W
R68	330-00647	Resistor, Metal Film, 301 K ±1%, 1/4 W

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
R69,R70,R75,R85,R91	360-00119	Potentiometer, Cermet, 50 K ±10%, Allen-Bradley 73B1G040S503W
R73	330-00626	Resistor, Metal Film, 182 K ±1%
R76	330-00385	Resistor, Metal Film, 750 Ω ±1%, 1/4 W
R77	330-00449	Resistor, Metal Film, 3.16 K ±1%, 1/4 W
R78	330-00427	Resistor, Metal Film, 1.87 K ±1%, 1/4 W
R81	330-00505	Resistor, Metal Film, 11 K ±1%, 1/4 W
R82,R93	330-00516	Resistor, Metal Film, 14.3 K ±1%, 1/4 W
R95,R98,R99-R102,R104		Not Used
R103	370-00020	Resistor, 0 Ω (Jumper)
TP1-TP7	420-00232	Header, 5-Position, 0.1 Centers
U1,U6	400-00665	Quad Op Amp, LM224J
U2	400-00639	Quad Op Amp, 4136DC
U3,U4,U11	560-00011	Op Amp, LM108J8
U5,U10	560-00012	Op Amp, MC1741
U7,U9	400-00636	Quad AND-Gate, MC14081
U8	540-00059	Hex Inverter, CD4049
REV A		

DELTA F BOARD, B-0346

	450-00121*	Printed Circuit Board. P-0827
C1	010-00418	Capacitor, Polycarbonate, 0.47 µF ±10%, 50 V, CDE WCP-05P47
C2	000-00717	Capacitor, Polyester, 0.027 µF ±10%, 50 V, CDE WMF-1S27
C3	010-00419	Capacitor, Polycarbonate, 2.0 µF ±1%, 50 V, F-DYNE MPC23

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
C4	010-00420	Capacitor, Polycarbonate, 0.22 µF ±10%, 100 V, CDE WMF-1S22
C5	010-00437	Capacitor, Polycarbonate, 1.5 µF ±10%, 50 V F-DYNE, MPC13-1.5-50-10
C6	000-00835	Capacitor, Polyester, 1 µF ±10%, 63 V Roederstein, MKT-1822-510-06-5
C7	000-00555	Capacitor, Tantalum, 4.7 µF ±20%, 25 V, Panasonic ECSF25E4R7
C8,C9,C13,C16	000-00917	Capacitor, Ceramic Disk, 0.01 µF ±20%, 50 V, Centralab UK50-103
C10-C12,C14,C15	000-00939	Capacitor, 0.0047 µF ±20%, 3 kV
C17	000-00533	Capacitor, 150 µF ±20 V dc
D1,D2,D11	400-00225	Diode, Fairchild, FD333
D3-D10	400-00224	Diode, 1N4148
K1	430-00151	Relay, 24 V, American Zettler AZ4-UP-E-1C-24V
Q1	400-00300	Transistor, NPN, 2N1711
P1,P2	420-00232	Header, 36-Position, 0.1 Centers
P3, P4	030-00039	Header, Assembly, 4-Position, AMP 2-350948-0
R1	330-00574	Resistor, Metal Film, 57.6 K ±1%, 1/4 W
R2	330-00668	Resistor, Metal Film, 499 K ±1%, 1/4 W
R3-R5	330-00630	Resistor, Metal Film, 200 K ±1%, 1/4 W
R6,R8	330-00601	Resistor, Metal Film, 100 K ±1%, 1/4 W, RN60E
R7	330-00626	Resistor, Metal Film, 182 K ±1%, 1/4 W
R9	200-00106	Resistor, Carbon Film, 10 M ±5%, 1/2 W
R10	360-00139	Potentiometer, 12-Turn, 100 K ±10%, Bourns 3266W-1-104
R11	360-00142	Potentiometer, 50 K

COMPONENT DESIGNATION	BECO NUMBER	DESCRIPTION
R12	200-00204	Resistor, Carbon Film, 200 K ±5%, 1/2 W
R13,R19	200-00203	Resistor, Carbon Film, 20 K ±5%, 1/2 W
R14	200-00365	Resistor, Carbon Film, 3.6 M ±5%, 1/2 W
R15		Not Used
R16	200-00513	Resistor, Carbon Film, 51 K ±5%, 1/2 W
R17	330-00568	Resistor, Metal Film, 49.9 Ω ±1%, 1/4 W, RN60E
R18	330-00473	Resistor, Metal Film, 5.62 K ±1%, 1/4 W, RN60E
R20	200-00273	Resistor, Carbon Film, 27 K 5%, 1/4 W
R21	360-00141	Potentiometer, 20 K 10%, 1/4 W
R22	330-00406	Resistor, Metal Film, 1.13 K ±1%, 1/4 W, RN60E
R23	330-00566	Resistor, Metal Film, 47.5 K ±1%, 1/4 W, RN60E
R24	330-00401	Resistor, Metal Film, 1.0 K ±1%, 1/4 W, RN60E
R25	360-00119	Potentiometer, 50 K ±10%
U1	400-00665	Quad Op Amp, National, LM224J
U2,U3	560-00012	Op Amp, Motorola MC1741
VR1,VR2	400-00724	Varistor, 250 V
VR3,VR4	400-00713	Varistor, 40 V

Rev A

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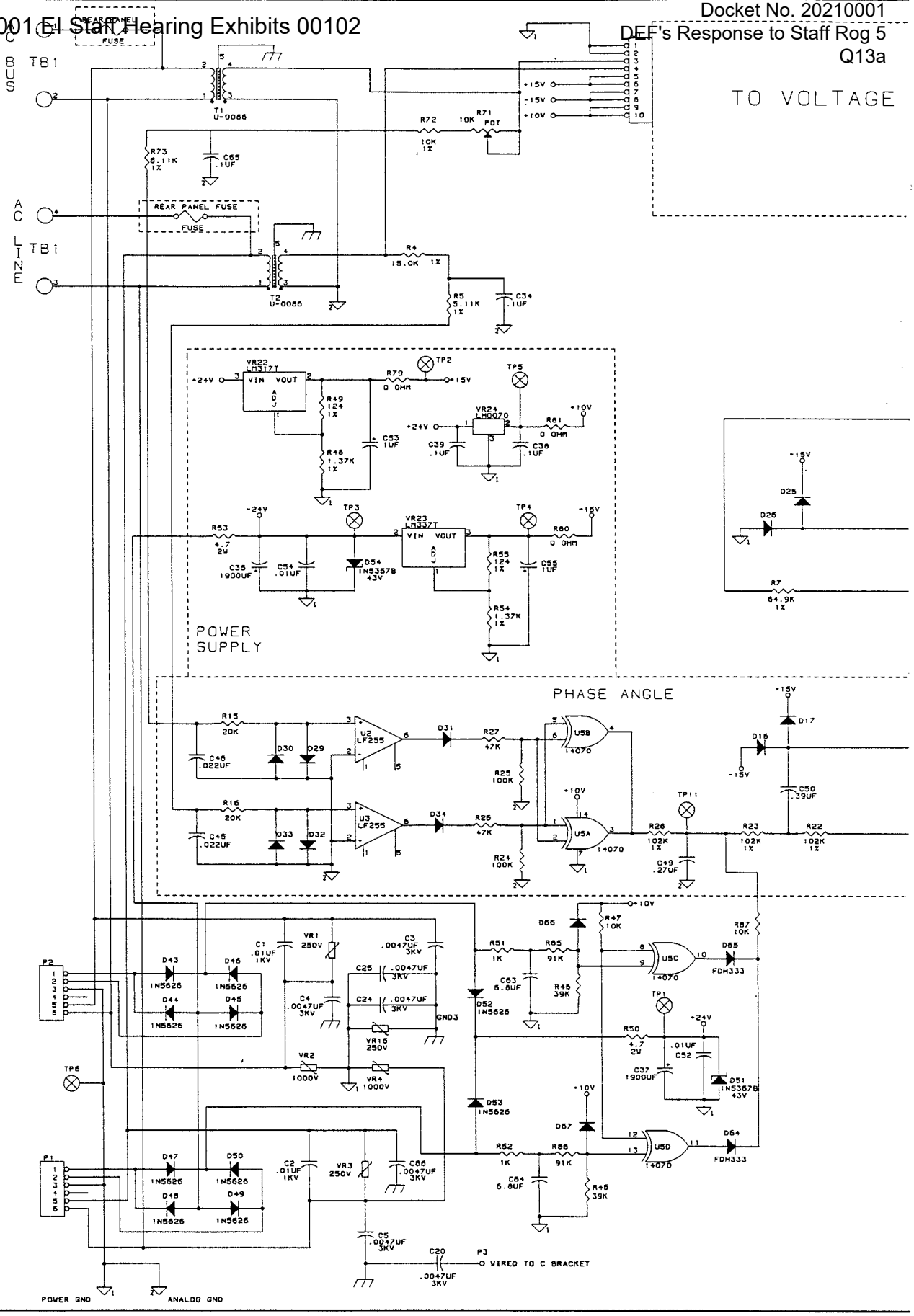

FIGURE 8a Phase Board Schematic

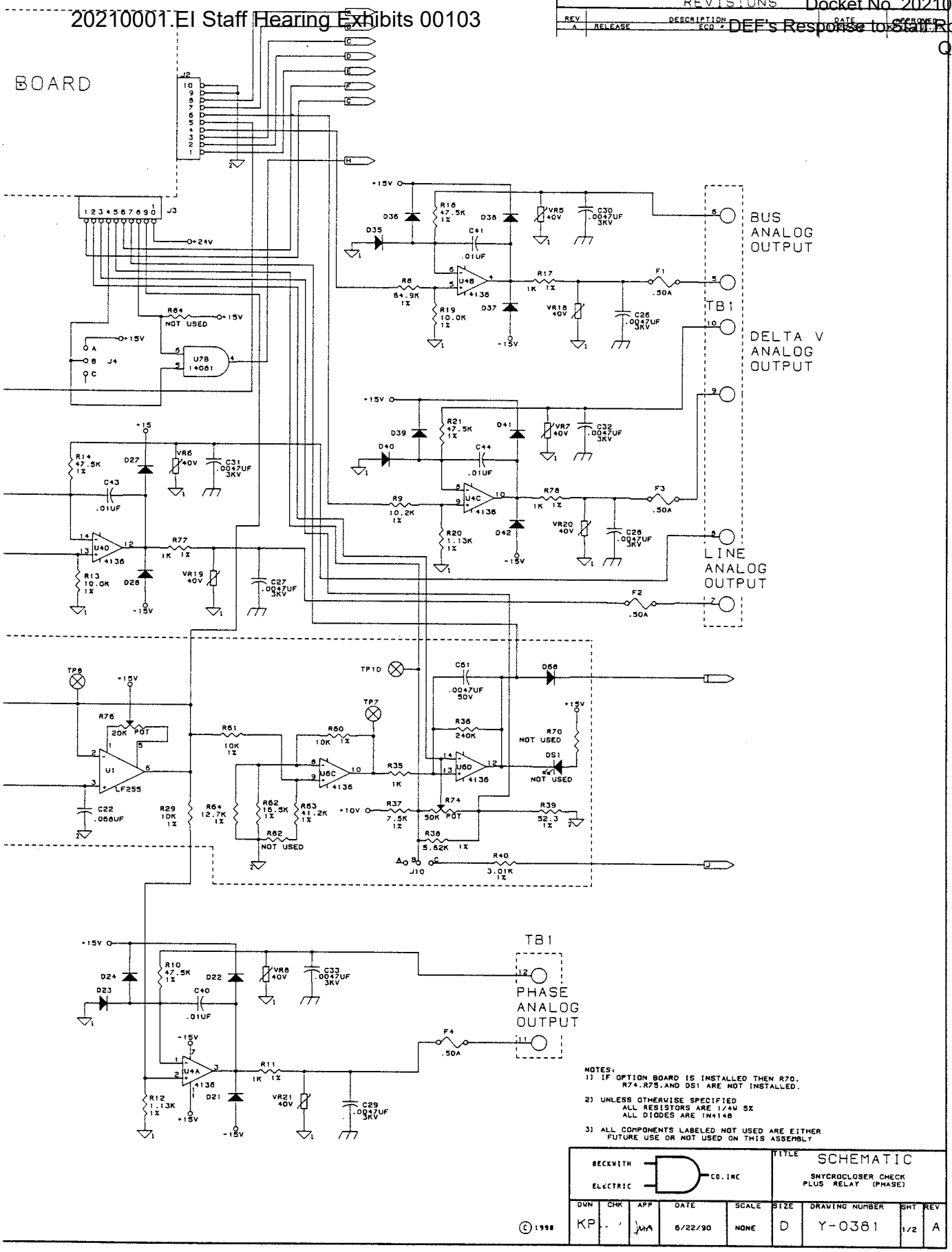

FIGURE 8b Phase Board Schematic

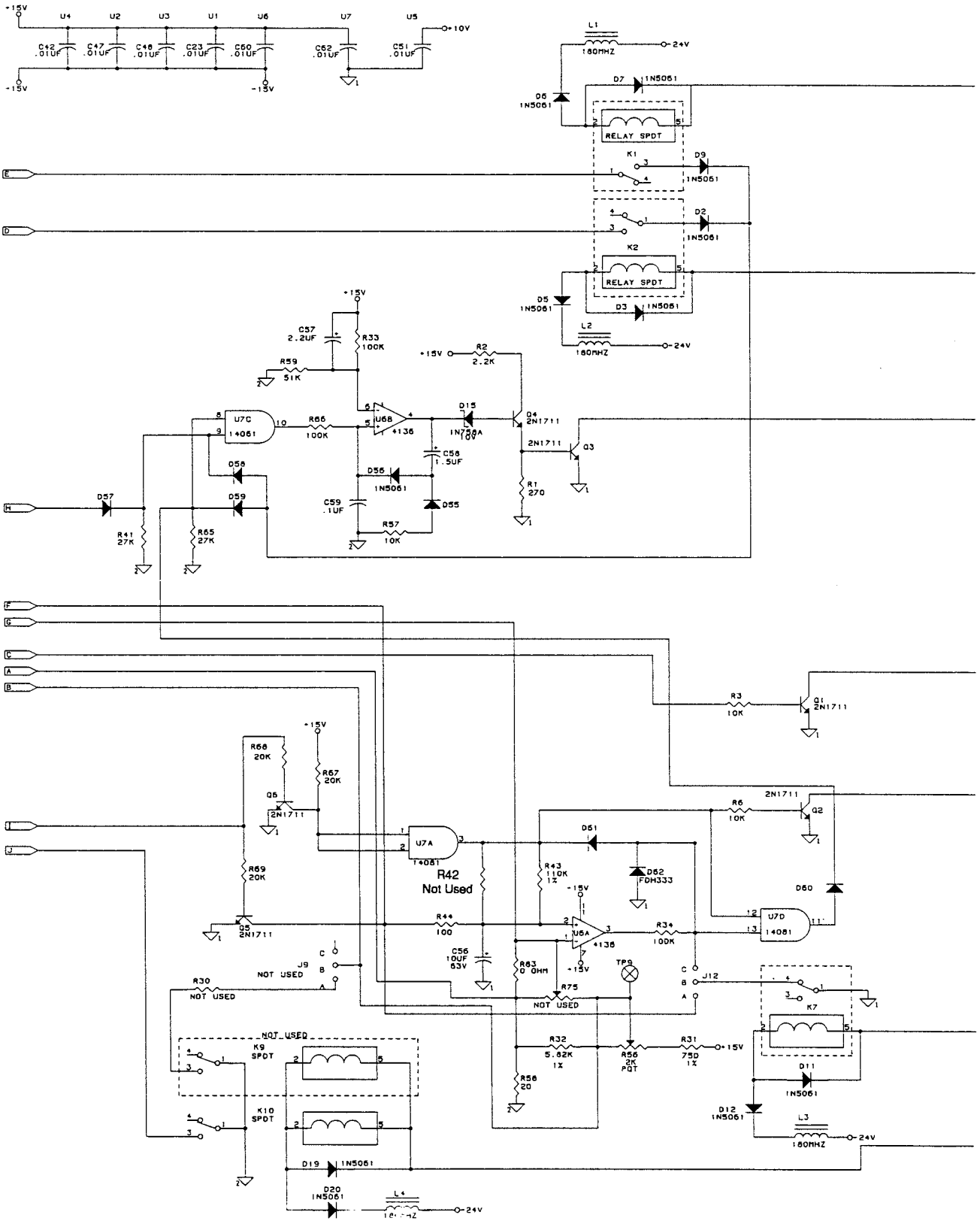

FIGURE 8c Phase Board Schematic

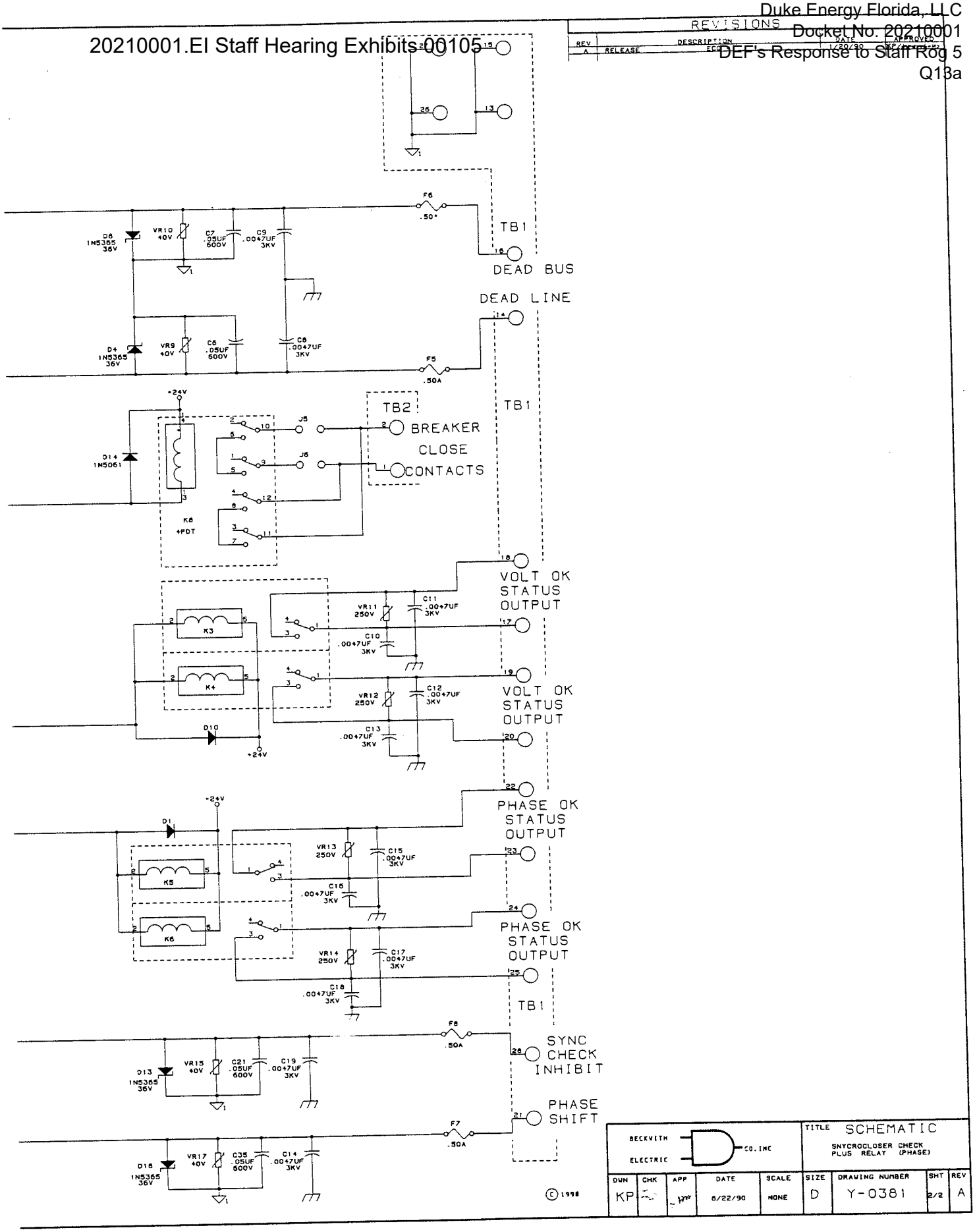

FIGURE 8d Phase Board Schematic

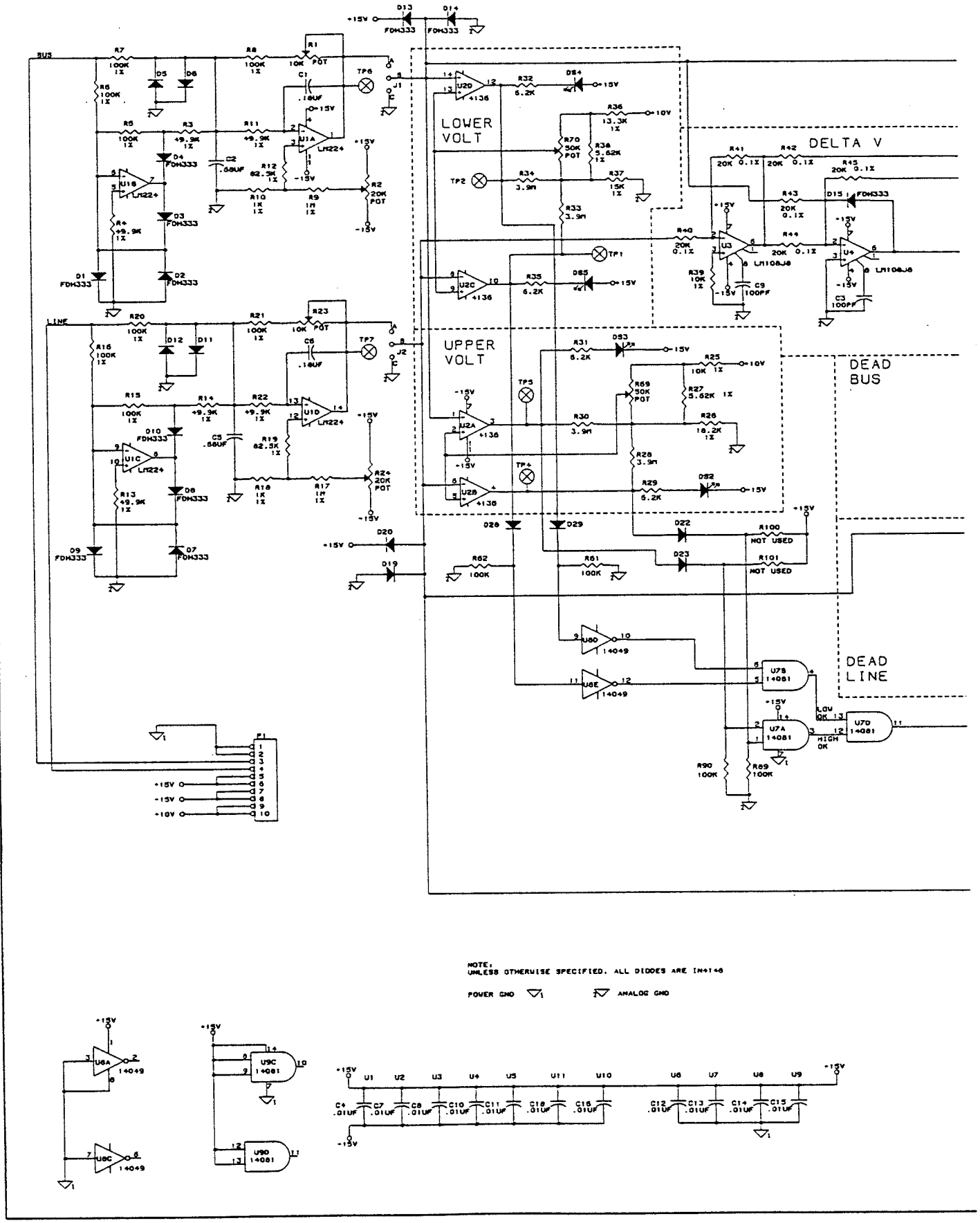

FIGURE 9a Voltage Board Schematic

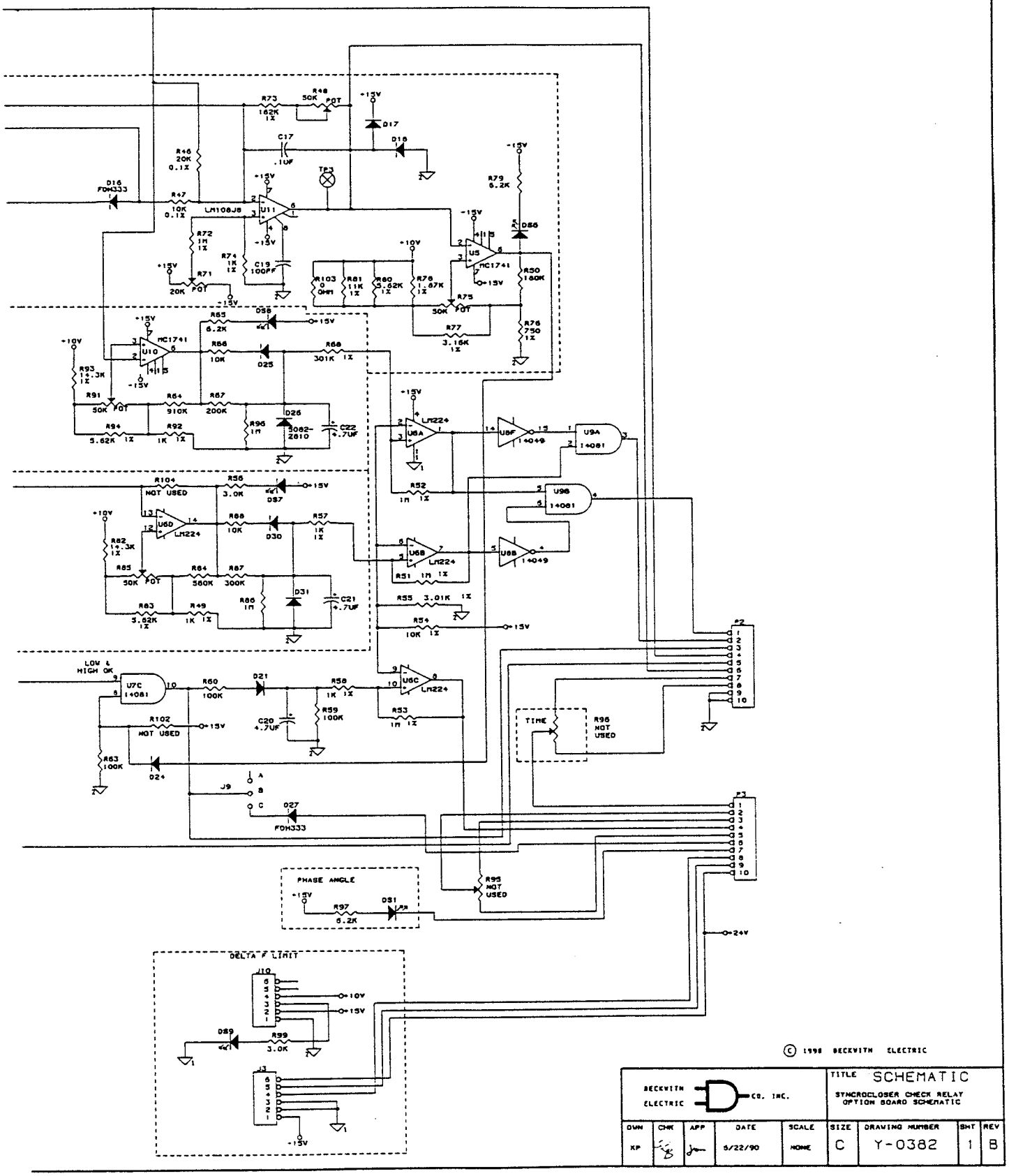

FIGURE 9b Voltage Board Schematic

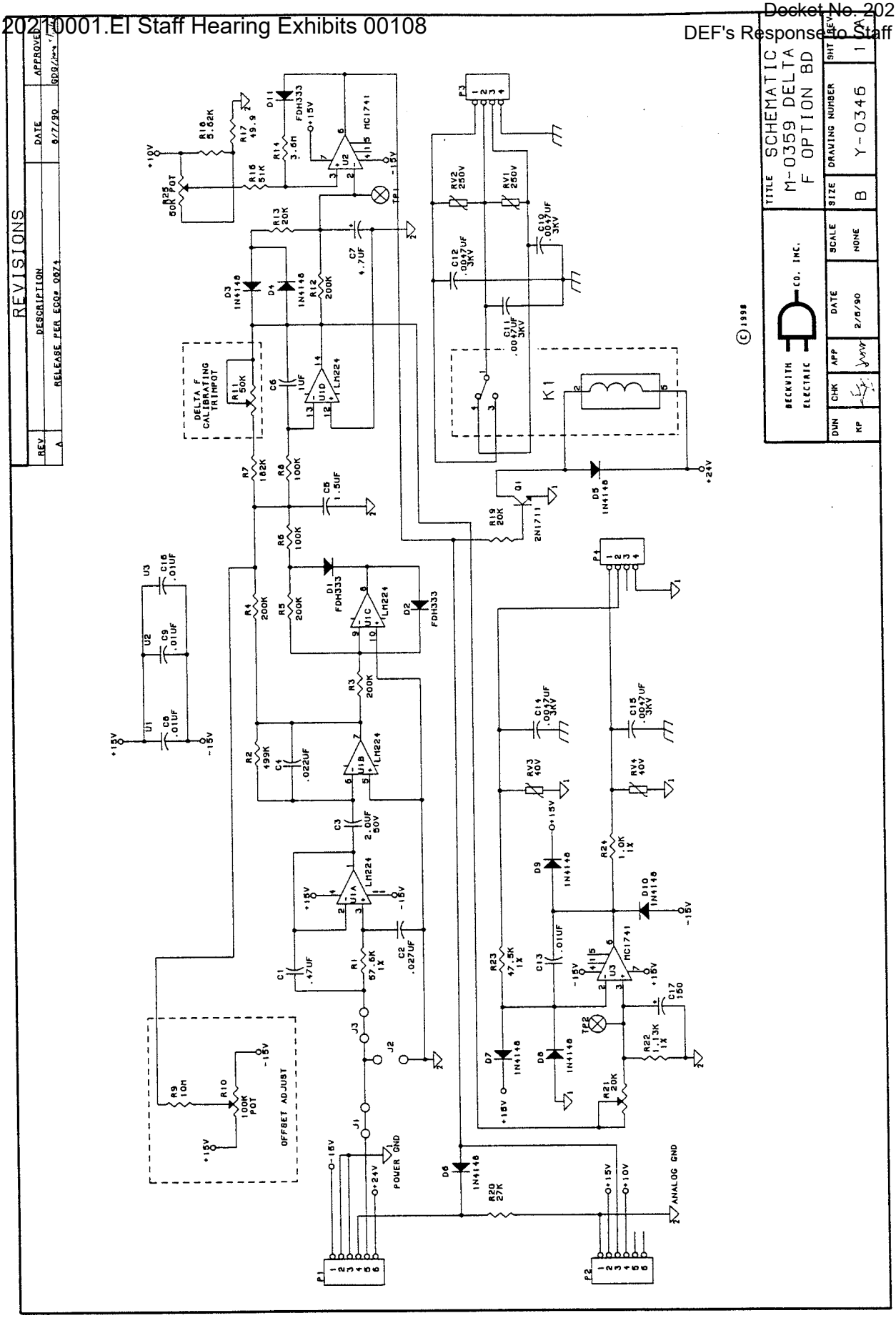

FIGURE 10 Delta F Board Schematic

Patent

The units described in this manual are covered by U.S. Patents, with other patents pending.

Buyer shall hold harmless and indemnify the Seller, its directors, officers, agents, and employees from any and all costs and expense, damage or loss, resulting from any alleged infringementof United States Letters Patent or rights accruing thereform or trademarks, whether federal, state, or common law, arising from the Seller's compliance with Buyer's designs, specifications, or instructions.

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 herein will be new and reasonably suitable for the equipment. Seller warrants that if, during a period of five years from date of shipment of the equipment, the equipment rendered shall be found by the Buyer to be faulty or shall fail to peform in accordance with Seller's specifications of the product, Seller shall at his expense correct the same, provided, however, that Buyers shall ship the equipment prepaid to Seller's facility. The Seller's responsibility hereunder shall be limited to replacement value of the equipment furnished under this contract.

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 contained herein. 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 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 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.

Notice:

Any illustrations and descriptions by Beckwith Electric Co., Inc. are for the sole purpose of identification.

The drawings and/or specifications enclosed herein are the proprietary property of Beckwith Electric Co., Inc., and are issued in strict confidence; therefore, shall not be used as a basis of reproduction of the apparatus described therein without written permission of Beckwith Electric Co., Inc.

No illustration or description contained herein shall be construed as an express warranty of affirmation, promise, description, or sample, and any and all such express warranties are specifically excluded nor shall such illustration or description imply a warranty that the product is merchantable or fit for a particular purpose. There shall be no warranties which extend beyond those contained in the Beckwith Electric Co., Inc. terms of sale.

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www.beckwithelectric.com
ISO 9001:2008

Printed in USA

800-0359-IB-00MC3 01/13

STATION: CRYSTAL RIVER PLANT
TYPE: Generator Protection, Synchronizing
VOLTAGE (KV): 230
DESIGNATION: UNIT#4 MAN SYNC/VOLT CHECK
BREAKER(S): 3233, 3234
DEVICE: 25/27
CATEGORY: ONLY
ACTIVE SETTING GROUP
RELAY SCHEME
S/N: 1711
FIRMWARE VER No. or FID No.

JUSTIFICATION: INSTALLATION

☐ ORIGINAL ☐ TEMP FILE COPY

THOR#
Equipment# 5600884
SHEET # 1 **OF** 1

RELAY MODEL	PHASE	PRINT CODE
M-0359	A, 3Ph or Other	5-F
	B	
	C	

LAST CALC BY:
LAST CALC DATE: 3/9/2002

SETTING NAME	SETTING	COMMENTS
PTR (/1)	1200	
UPPER VOLTAGE LIMIT	121 120.93 B / 120.94 G	251KV (+5%)
LOWER VOLTAGE LIMIT	110 109.87 B / 119.98 G	228KV (-5%)
DELTA V LIMIT	2 2.1	DELTA 4.2KV (Ph-Ph)
DEAD LINE LIMIT	50 49.87	USED (Black Start)
DEAD BUS LIMIT	50 49.94	NOT USED
PHASE ANGLE LIMIT	15 15.13 B / 345.02 G	
DELTA F LIMIT	0.06 .0101	

CASCADE W.O. 2013-3004193410 MX 2014-3004245604 CALIBRATION

ABOVE READINGS ARE AS FOUND / AS LEFT

********** All changes to this section must be reviewed by Transmission Engineering **********
(Applicable only for relay replacement or new installation performed by Construction or Maintenance).

New relay installation verification check list.

☐ Relay inputs in use verified ☐ Relay outputs in use verified ☐ Relay targets verified
☐ Final after testing - Setting file in relay is verified

Testing Performed
☐ Relay test software (RTS) or ☐ Manual

Test Personnel: _____

☐ Functional Testing Complete This relay has been tested and commissioned according to Progress Energy Procedures: Protective Relaying for Technicians, Chapter 25, Apendex B, "Minimum Requirements for Acceptance on Capital Projects".

Test Personnel: _____ Date: ___/___/___

ENG COMMENTS: (HISTORIC) Supervises Manual Closes.

ENG REMARKS: (CURRENT) Fill in as installed Values.

FIELD COMMENTS: _____

Underfrequency Set Points
A=59.7+12cy, B=59.4+12cy, C=59.1+12cy, D=58.8+12cy, E=58.5+12cy, F=58.2+12cy, L=59.4+10sec, M=59.7+12sec, N=59.1+8sec, NT=No Trip

********** RELAY TECHNICIAN CHECK LIST **********

1). Sign/Print your name and Date Setting Sheet
2). Record S/N & Firmware Version for IED rly's and FID for all SEL rly's
3). Markup chg's to electromechanical rly's on setting sheet
4). Download settings from IED rly's into electronic file and e-mail to: relaysettings@duke-energy.com
5). Verify complete relay model number & record if not shown
6). Return Setting Sheet to the appropiate Const./ Maint. Engineer
☐ 7). Verify all CT ratios related to this setting sheet

PEER CHECK BY: 0
ISSUED BY: PARRIS VAN SMITH INTL: _____
ISSUE DATE: 9/12/2014

INSTALLATION BY: Michael L. Benson DATE 11/23/2014
PRINT NAME MICHAEL L. BENSON

RTS Relay Test Results

Powered by: ENOSERV

Lib Routine: M-0359.FL_LIB **AF/AL:** AF **Pass/Fail:** PASS

Lib Version: 1.0 **Test Date:** 03/11/2018

Relay Data:

TESTED_BY:	R.GERHARDT	DIVISION:	FL-NORTH COASTAL
SUBSTATION:	CRPL-S4 604	TERMINAL:	UNIT 4 syncloser M0359
PRINT_CODE:	5F	PHASE_ZONE:	ABC
RELAY_MANF:	BECKWITH	RELAY_TYPE:	M-0359
MODEL_STYLE:	M-0359	IEEE_DEVICE:	
IL_IB:		SERIAL_NUMBER:	NA
FIRMWARE:		RELAY_ID:	5600884
WO_NUMBER:		REASON_FOR_TEST:	MAINTENANCE
NERC_AUDITABLE:		NERC_SUBNUM:	
MAINT_INTERVAL:		PREVIOUS_TESTDATE:	
CURRENT_TESTDATE:	3/11/2018	NEXT_TESTDATE:	
TESTSET_CALDATE:		APPROVED_BY:	

Global Defines:

Routine Notes:

Relay Settings Used for Testing:

TEST_VOLTS=	115	CLOSE_ANGLE=	15	DEAD_LINE=	50
DEAD_BUS=	50	LV_LIMIT=	110	UV_LIMIT=	121
NORM_FREQ=	60	FREQ_DIFF=	.006		

Relay Test Results for: CLOSING ANGLE

LAGGING ANGLE	IDEAL	RANGE	OK?
14.97	15.00	10.00 TO 20.00	PASS

LEADING ANGLE	IDEAL	RANGE	OK?
344.85	345.00	340.00 TO 350.00	PASS

Relay Test Results for: LVL LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
109.450	110.000	106.700 TO 113.300	PASS

Relay Test Results for: UVL LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
121.000	121.000	114.950 TO 127.050	PASS

Relay Test Results for: LVB LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
109.450	110.000	106.700 TO 113.300	PASS

Relay Test Results for: UVB LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
121.000	121.000	117.370 TO 124.630	PASS

Relay Test Results for: DEAD LINE LIMIT

PICKUP VOLTS	IDEAL	RANGE	OK?
49.500	50.000	48.500 TO 51.500	PASS

Relay Test Results for: DEAD BUS LIMIT

PICKUP VOLTS	IDEAL	RANGE	OK?
49.500	50.000	48.500 TO 51.500	PASS

Relay Test Results for: UF LIMIT

PICKUP HZ	IDEAL	RANGE	OK?
59.997	59.994	59.969 TO 60.019	PASS

Relay Test Results for: OF LIMIT

PICKUP HZ	IDEAL	RANGE	OK?
60.003	60.006	59.981 TO 60.131	PASS

RTS Relay Test Results

Powered by: ENOSERV

Lib Routine: M-0359.FL_LIB **AF/AL:** AL **Pass/Fail:** PASS

Lib Version: 1.0 **Test Date:** 03/11/2018

Relay Data:

TESTED_BY:	R.GERHARDT	DIVISION:	FL-NORTH COASTAL
SUBSTATION:	CRPL-S4 604	TERMINAL:	UNIT 4 syncloser M0359
PRINT_CODE:	5F	PHASE_ZONE:	ABC
RELAY_MANF:	BECKWITH	RELAY_TYPE:	M-0359
MODEL_STYLE:	M-0359	IEEE_DEVICE:	
IL_IB:		SERIAL_NUMBER:	NA
FIRMWARE:		RELAY_ID:	5600884
WO_NUMBER:		REASON_FOR_TEST:	MAINTENANCE
NERC_AUDITABLE:		NERC_SUBNUM:	
MAINT_INTERVAL:		PREVIOUS_TESTDATE:	
CURRENT_TESTDATE:	3/11/2018	NEXT_TESTDATE:	
TESTSET_CALDATE:		APPROVED_BY:	

Global Defines:

Routine Notes:

Relay Settings Used for Testing:

TEST_VOLTS=	115	CLOSE_ANGLE=	15	DEAD_LINE=	50
DEAD_BUS=	50	LV_LIMIT=	110	UV_LIMIT=	121
NORM_FREQ=	60	FREQ_DIFF=	.006		

Relay Test Results for: CLOSING ANGLE

LAGGING ANGLE	IDEAL	RANGE	OK?
14.97	15.00	10.00 TO 20.00	PASS

LEADING ANGLE	IDEAL	RANGE	OK?
344.85	345.00	340.00 TO 350.00	PASS

Relay Test Results for: LVL LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
109.450	110.000	106.700 TO 113.300	PASS

Relay Test Results for: UVL LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
121.000	121.000	114.950 TO 127.050	PASS

Relay Test Results for: LVB LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
109.450	110.000	106.700 TO 113.300	PASS

Relay Test Results for: UVB LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
121.000	121.000	117.370 TO 124.630	PASS

Relay Test Results for: DEAD LINE LIMIT

PICKUP VOLTS	IDEAL	RANGE	OK?
49.500	50.000	48.500 TO 51.500	PASS

Relay Test Results for: DEAD BUS LIMIT

PICKUP VOLTS	IDEAL	RANGE	OK?
49.500	50.000	48.500 TO 51.500	PASS

Relay Test Results for: UF LIMIT

PICKUP HZ	IDEAL	RANGE	OK?
59.997	59.994	59.969 TO 60.019	PASS

Relay Test Results for: OF LIMIT

PICKUP HZ	IDEAL	RANGE	OK?
60.003	60.006	59.981 TO 60.131	PASS

STATION: CRYSTAL RIVER PLANT
JUSTIFICATION: CHANGE
THOR/PROJECT# 2836S2
TYPE: Generator Protection
VOLTAGE (KV): 230
DESIGNATION: UNIT#4 MAN SYNC/VOLT CHECK
BREAKER(S): 3233, 3234
DEVICE: 25/27
CATEGORY: ONLY
ACTIVE SETTING GROUP
RELAY SCHEME
S/N: 1711
FIRMWARE VER No. or FID No.

☒ ORIGINAL ☐ TEMP FILE COPY
Equipment# 5600884
SHEET # 1 **OF** 1

RELAY MODEL	PHASE	PRINT CODE
M-0359	A, 3Ph or Other	5-F/43-C
	B	
	C	

LAST CALC BY: PARRIS VAN SMITH
LAST CALC DATE: 3/9/2002
CUSTOMER OWNED (Y/N):

SETTING NAME	SETTING		COMMENTS
PTR (/1)	1200	AF / AL	
UPPER VOLTAGE LIMIT	121	120.75 / 120.75	251KV (+5%)
LOWER VOLTAGE LIMIT	110	112.7 / 109.45	223KV (-5%)
DELTA V LIMIT	2	2.67 / 2.07	DELTA 4.2KV (Ph-Ph)
DEAD LINE LIMIT	50	50.21 / 50.17	USED (Black Start)
DEAD BUS LIMIT	50	N/A / N/A	NOT USED
PHASE ANGLE LIMIT	15	15.14 / 15.14	
DELTA F LIMIT	0.06	0.062 / 0.062	

********** All changes to this section must be reviewed by Transmission Engineering **********
(Applicable only for relay replacement or new installation performed by Construction or Maintenance).
New relay installation verification check list.

☒ Relay inputs in use verified ☒ Relay outputs in use verified ☒ Relay targets verified
N/A Final after testing - Setting file in relay is verified

Testing Performed
☐ Relay test software (RTS) or ☒ Manual
Test Personnel: Michael K. Brown

☒ Functional Testing Complete This relay has been tested and commissioned according to Duke Energy Procedures: Protective Relaying for Technicians, Chapter 25, Apendex B, "Minimum Requirements for Acceptance on Capital Projects".
Test Personnel: Michael K. Brown Date: 04/29/2020

ENG COMMENTS: (HISTORIC) Supervises Manual Closes.

ENG REMARKS: (CURRENT) Issuing setting sheet due to relocation of relay from Panel 5-F in the 230 kV control house to new 230/500 kV CEE, Panel 43-C. No change of settings.

FIELD COMMENTS:

Underfrequency Set Points
1=59.6+10cy, 2=59.4+10cy, 3=59.2+10cy, 4=59.0+10cy, 5=58.7+10cy, 6=58.4+10cy, 7=58.2+10cy, 8=59.6+15sec, 9=59.6+22sec, NT=No Trip

********** RELAY TECHNICIAN CHECK LIST **********
1). Markup changes to electromechanical relays on setting sheet
2). Revise setting file name above to As-Left with corresponding Date.
3). Record S/N & Firmware Version for IED rly's and FID for all SEL rly's
4). Verify complete relay model number & record if not shown
5). Verify all CT ratios related to this setting sheet
6). Add Electronic Signature
7). E-mail Setting Sheet and As-Left Setting File To: relaysettings@duke-energy.com and to the RCE

PREPARED BY: JAMES FERRELL 407-739-4375
James Ferrell Digitally signed by James Ferrell Date: 2020.01.30 15:18:37 -05'00'
Preparer's Signature

PEER REVIEW BY: MARK WAGNER
MARK WAGNER Digitally signed by MARK WAGNER Date: 2020.02.06 13:20:08 -05'00'
Reviewer's Signature

Michael K. Brown
Relay Tech Signature

RTS Relay Test Results

Progress Energy

Test Date: **AF/AL:** AF **Pass/Fail:** PASS

Relay Data:

Company_Name:	P.E. Florida	Area:	OC/WW Relay
Substation:	CRPL U4	Terminal:	Unit 4
Generator			
Panel_Bkr:	5-F (230 House)	Phase_Zone:	Synch Check
Relay_Manf:	Beckwith	Relay_Type:	Syncrocloser
Model_Style:	M-0359	Serial_Number:	NA
IL_IB:		Test_Date:	11/19/2011
Tested_By:	D. McCutchen	Reason_For_Test:	MJR. MAINT.
PassPort_EQ_Number:	N/A	PassPort_WO_Number:	
Aspen_Relay_Group_Number:	5600884		

Routine Notes:

<undefined>

Relay Settings Used for Testing:

RATED_AC=	120	TEST_VOLTS=	115	Lower_V_Limit=	110
Upper_V_Limit=	121	Delta_V_Limit=	2	Phase_Angle=	15
Delta_F_Limit=	0.05	Dead_Line_Limit=	50	Dead_Bus_Limit=	50
NOM_FREQ=	60				

SENSE-Upper Voltage Limit Bus TEST

SENSE-UPPER VOLTAGE LIMIT BUS TEST

DROPOUT VOLTS	IDEAL	RANGE	OK?
120.879	121.000	117.370 TO 124.630	PASS

SENSE-Upper Voltage Limit Line TEST

SENSE-UPPER VOLTAGE LIMIT LINE TEST

DROPOUT VOLTS	IDEAL	RANGE	OK?
120.879	121.000	117.370 TO 124.630	PASS

SENSE-Lower Voltage Limit Bus TEST

SENSE-LOWER VOLTAGE LIMIT BUS TEST

DROPOUT VOLTS	IDEAL	RANGE	OK?
109.890	110.000	106.700 TO 113.300	PASS

SENSE-Lower Voltage Limit Line TEST

SENSE-LOWER VOLTAGE LIMIT LINE TEST

DROPOUT VOLTS	IDEAL	RANGE	OK?
109.890	110.000	106.700 TO 113.300	PASS

SENSE-Phase Angle Limit TEST

SENSE-PHASE ANGLE LIMIT TEST

LAGGING ANGLE	IDEAL	RANGE	OK?
15.00	15.00	13.00 TO 17.00	PASS

LEADING ANGLE	IDEAL	RANGE	OK?
344.50	345.00	343.00 TO 347.00	PASS

SENSE-Delta V TEST

SENSE-DELTA V TEST

DELTA V PICKUP	SET POINT	RANGE	OK?
2.05	2.00	1.65 TO 2.35	PASS

SENSE-Dead Line Limit TEST

SENSE-DEAD LINE LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
49.750	50.000	47.500 TO 52.500	PASS

SENSE-Dead Bus Limit Test

SENSE-DEAD BUS LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
49.750	50.000	47.500 TO 52.500	PASS

SENSE-Delta Frequency NO-OP

SENSE-DELTA FREQUENCY NO-OP

APPLIED FREQUENCY	REFERENCE FREQUENCY	OPERATION EXPECTED?	OPERATION OCCUR?	OK?
59.94	60.00	NO	NO	PASS

SENSE-Delta Frequency TEST

SENSE-DELTA FREQUENCY TEST

PICKUP HZ	RANGE	OK?
59.940	59.920 TO 59.980	PASS

DROPOUT HZ	RANGE
59.960	59.920 TO 59.980

RTS Relay Test Results

Progress Energy

Test Date: **AF/AL:** AL **Pass/Fail:** PASS

Relay Data:

Company_Name:	P.E. Florida	Area:	OC/WW Relay
Substation:	CRPL U4	Terminal:	Unit 4
Generator			
Panel_Bkr:	5-F (230 House)	Phase_Zone:	Synch Check
Relay_Manf:	Beckwith	Relay_Type:	Syncrocloser
Model_Style:	M-0359	Serial_Number:	NA
IL_IB:		Test_Date:	11/19/2011
Tested_By:	D. McCutchen	Reason_For_Test:	MJR. MAINT.
PassPort_EQ_Number:	N/A	PassPort_WO_Number:	
Aspen_Relay_Group_Number:	5600884		

Routine Notes:

<undefined>

Relay Settings Used for Testing:

RATED_AC=	120	TEST_VOLTS=	115	Lower_V_Limit=	110
Upper_V_Limit=	121	Delta_V_Limit=	2	Phase_Angle=	15
Delta_F_Limit=	0.05	Dead_Line_Limit=	50	Dead_Bus_Limit=	50
NOM_FREQ=	60				

SENSE-Upper Voltage Limit Bus TEST

SENSE-UPPER VOLTAGE LIMIT BUS TEST

DROPOUT VOLTS	IDEAL	RANGE	OK?
120.879	121.000	117.370 TO 124.630	PASS

SENSE-Upper Voltage Limit Line TEST

SENSE-UPPER VOLTAGE LIMIT LINE TEST

DROPOUT VOLTS	IDEAL	RANGE	OK?
120.879	121.000	117.370 TO 124.630	PASS

SENSE-Lower Voltage Limit Bus TEST

SENSE-LOWER VOLTAGE LIMIT BUS TEST

DROPOUT VOLTS	IDEAL	RANGE	OK?
109.890	110.000	106.700 TO 113.300	PASS

SENSE-Lower Voltage Limit Line TEST

SENSE-LOWER VOLTAGE LIMIT LINE TEST

DROPOUT VOLTS	IDEAL	RANGE	OK?
109.890	110.000	106.700 TO 113.300	PASS

SENSE-Phase Angle Limit TEST

SENSE-PHASE ANGLE LIMIT TEST

	IDEAL	RANGE	OK?
LAGGING ANGLE 15.00	15.00	13.00 TO 17.00	PASS
LEADING ANGLE 344.50	345.00	343.00 TO 347.00	PASS

SENSE-Delta V TEST

SENSE-DELTA V TEST

DELTA V PICKUP	SET POINT	RANGE	OK?
2.05	2.00	1.65 TO 2.35	PASS

SENSE-Dead Line Limit TEST

SENSE-DEAD LINE LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
49.750	50.000	47.500 TO 52.500	PASS

SENSE-Dead Bus Limit Test

SENSE-DEAD BUS LIMIT TEST

PICKUP VOLTS	IDEAL	RANGE	OK?
49.750	50.000	47.500 TO 52.500	PASS

SENSE-Delta Frequency NO-OP

SENSE-DELTA FREQUENCY NO-OP

APPLIED FREQUENCY	REFERENCE FREQUENCY	OPERATION EXPECTED?	OPERATION OCCUR?	OK?
59.94	60.00	NO	NO	PASS

SENSE-Delta Frequency TEST

SENSE-DELTA FREQUENCY TEST

PICKUP HZ	RANGE	OK?
59.940	59.920 TO 59.980	PASS

DROPOUT HZ	RANGE
59.960	59.920 TO 59.980

AFFIDAVIT

STATE OF FLORIDA

COUNTY OF PINELLAS

I hereby certify that on this 6th day of October 2021, before me, an officer duly authorized in the State and County aforesaid to take acknowledgments, personally appeared GARY P. DEAN, who is personally known to me, and has acknowledged before me that he provided the answers to interrogatory numbers 8 and 10, of STAFF'S FIFTH SET OF INTERROGATORIES TO DUKE ENERGY FLORIDA, LLC (NOS. 8-14) in Docket No. 20210001-EI, and that the responses are true and correct based on his personal knowledge.

THE FOREGOING INSTRUMENT was sworn to and subscribed before me by means of ☐ physical presence or **X** online (video) notarization by Gary Dean, who is personally known to me.

In Witness Whereof, I have hereunto set my hand and seal in the State and County aforesaid as of this 6th day of October, 2021.

Gary P. Dean

MONIQUE WEST
MY COMMISSION # GG 343812
EXPIRES: June 28, 2023
Bonded Thru Notary Public Underwriters

Notary Public
State of Florida

My Commission Expires: 6/28/23

AFFIDAVIT

STATE OF NORTH CAROLINA

COUNTY OF MECKLENBURG

I hereby certify that on this 9th day of Oct, 2021, before me, an officer duly authorized in the State and County aforesaid to take acknowledgments, personally appeared INGLE LEWTER, who is personally known to me, and has acknowledged before me that she provided the answer to interrogatory number 9, of STAFF'S FIFTH SET OF INTERROGATORIES TO DUKE ENERGY FLORIDA, LLC (NOS. 8-14) in Docket No. 20210001-EI, and that the responses are true and correct based on her personal knowledge.

In Witness Whereof, I have hereunto set my hand and seal in the State and County aforesaid as of this 9th day of October, 2021.

Ingle Lewter

Ingle Lewter

RAJ PATEL
NOTARY PUBLIC
Mecklenburg County, NC
My Commission Expires June 12, 2023

Mecklenburg County, NC
The foregoing instrument was acknowledged before me on this 9TH day of OCTOBER, 2021 by MARY INGLE LEWTER, who acknowledged to me that he or she willingly signed and executed the instrument for the purposes stated in it.

Raj Patel
Notary Public

AFFIDAVIT

STATE OF FLORIDA

COUNTY OF CITRUS

I hereby certify that on this 14th day of Oct., 2021, before me, an officer duly authorized in the State and County aforesaid to take acknowledgments, personally appeared JOSEPH SIMPSON, who is personally known to me, and has acknowledged before me that he provided the answers to interrogatory numbers 11, 12, 13, and 14, of STAFF'S FIFTH SET OF INTERROGATORIES TO DUKE ENERGY FLORIDA, LLC (NOS. 8-14) in Docket No. 20210001-EI, and that the responses are true and correct based on his personal knowledge.

In Witness Whereof, I have hereunto set my hand and seal in the State and County aforesaid as of this 14th day of October, 2021.

DEANNA LEE CARVER
Commission # GG 239923
Expires July 18, 2022
Bonded Thru Troy Fain Insurance 800-385-7019

Joseph Simpson

Notary Public
State of Florida

My Commission Expires: July 18, 2022