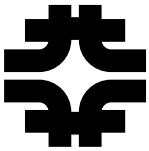

Fermi National Accelerator Laboratory

FERMILAB-TM-2011

Siemens Programmable Variable Speed DC Drives Applied to Wet and Dry Expansion Engines

Daniel J. Markley

Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510

July 1997

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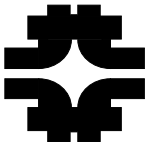

Fermi National Accelerator Laboratory

Siemens Programmable Variable Speed DC Drives Applied to Wet and Dry expansion engines

Fermilab Technical Memo TM-2011

Daniel J. Markley
July 97

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Contents **page**

These drawings and this Technical Memo are available in a PDF file format for viewing, printing, and plotting from the Internet at http://dmacs-nt-server.fnal.gov/. A free PDF viewer is available from the Adobe website. There is a hotlink at http://dmacs-nt-server.fnal.gov/ that will take you to the Adobe website.

I ABSTRACT

This document describes the technical details of the Siemens SIMOREG line of DC variable speed drives as applied to Fermilab wet and dry mechanical expander engines. The expander engines are used throughout the lab in Helium refrigerator installations.

II INTRODUCTION

Standardized Helium refrigerators are used throughout Fermilab. Two components of the refrigerators are wet and dry mechanical expander engines. The Typical Lab engines are driven by GE Variable speed drives approximately 10 to 20 years old. These drives are of discrete component technology and have had many custom modifications made to them.

Dzero has reviewed modern programmable variable speed DC regenerative drives and decided to use the Siemens SIMOREG line of drives. There were many factors in choosing a drive, but one of the biggest was that Dzero uses the Siemens/TI line of Programmable Logic Controllers (PLC's). This line of PLC's can communicate with up to 16 SIMOREG drives with one single communication port. It should be noted that Dzero did not use this available communication port, but communicates with the drives through discrete signal lines. The importance of this is that by duplicating the Dzero setup, the SIMOREG drive can be used with any control system that has analog and discrete I/O.

Most Lab wet engines are interchangeable as are the dry engines. Dzero has left the engines themselves unmodified as to maintain this interchangeability.

The drive that powers the expander engines must initially apply torque in one direction to start the engine rotating, then reverse the torque once the engine is being driven by the compressor discharge Helium gas pressure.

The DC drives are controlled directly from the Siemens Programmable Logic Controller (PLC) through a few discrete and analog I/O. The older GE drives have a local/remote switch that allows the drive to be controlled by a computer system or by the controls on the drive panel. The Siemens drives have been configured with no local controls, only remote controls. Local Control is not believed to be needed at this time. The external keypad can scroll through all the drive settings and current parameter values. The external keypad also has start, stop and reset buttons. The external keypad's start button is programmed to be inoperative since the drive is configured to operate only in a remote mode. The external key pad's stop and reset buttons still are functional.

The DC drive must be responsive to a number of interlock conditions. These interlocks are programmed into the drive and are sensed by its external input and output connections.

III SIMOREG DESCRIPTION

The SIMOREG 64RA24 is a DC programmable variable speed DC regenerative 4 quadrant drive. SIMOREG converters are fully-digital compact converters for connection to a three phase AC line to provide armature and field supplies for DC variable-speed motors. They are rated for continuous duty.

The SIMOREG modular design provides a service friendly enclosure where components are easily accessed. The electronics boards can be swung out and removed for access to the power circuits. The drive software is provided in a plug-in EPROM module.

The drive has:

1 analog speed input
3 programmable analog inputs

1 armature current analog output
3 programmable analog outputs

1 on/off binary input
1 regulator enable binary input
1 fault acknowledge binary input
5 programmable binary inputs

4 programmable binary outputs

The SIMOREG drive processor monitors many parameters of the drive, power inputs, and power outputs for values out of tolerance and will shut itself down on a fault if needed. The drive can detect input power phasing and voltage problems. The drive monitors itself for temperature and overload conditions. The drive monitors output power to the motor for voltage and current limits as well as overload conditions.

The power components of the drive are protected by specially rated fuses for power semiconductors. These fuses are designed to protect the power semiconductors by opening during a short circuit condition before the semiconductor is damaged.

The SIMOREG drive has many capabilities built into it that weren't take advantage of in this installation. It can monitor parameters such as motor bearing wear, motor temperature, and brake lining wear. These features aren't needed at this time, but they could be utilized in future installations.

IV SIMOREG INSTALLATION

WARNING: These drives contain and output lethal voltages and currents. They also power equipment with hazardous mechanical rotating parts. Only qualified personnel should install and maintain these units.

The SIMOREG drives require a 208 Volts AC input. This power should be provided from a line isolation transformer. The drives will need an enclosure, breaker, and disconnect setup. There is also an external keypad that can be used, at Dzero the keypad is mounted in the front of the Hoffman enclosure containing the drive.

Both the wet and dry drive are powered from the same isolation transformer, therefore a line reactor is needed on the wet drive.

These drives are connected to a commercial power source and must be installed following the National Electric Code (NEC).

Each engine has a small junction box with a connector that provides all the I/O between the drive and the engine components. Some I/O is 110 VAC and others are 24 VDC.

The drive outputs from the drive to the engine:
1. Solenoid valve that controls the Helium inlet valve.
2. The drive motor cooling fan.
3. Hour meter.

The drive inputs from the engine to the drive:
1. Emergency stop button.
2. Overspeed Brake trip.
3. Motor high Temperature trip.

4. Tachometer.

Each drive has I/O connections from the drive to the control system, usually a PLC or a DCS. These I/O are all low voltage. The ( ) indicates how the I/O point is currently programmed.

The drive outputs from the drive to the control system.

1. Armature Current.
2. Programmable Analog Output #1 (speed)
3. Programmable Analog Output #2 (Torque)
4. Programmable Analog Output #3 (Last Fault)
5. Programmable Analog Output #4 (Unused)

6. Programmable Binary Output #1 (No Fault)
7. Programmable Binary Output #2 (Running)
8. Programmable Binary Output #3 (Ready to Start)
9. Programmable Binary Output #4 (Unused)

The Drive inputs from the control system to the drive:

1. Speed Reference
2. Programmable Analog Input #1 (Unused)
3. Programmable Analog Input #2 (Unused)
4. Programmable Analog Input #3 (Unused)

5. On/Off Control
6. Regulator Enable
7. fault Acknowledge
8. Programmable Binary Input #1 (Overspeed Brake engaged Switch)
9. Programmable Binary Input #2 (Tachometer Cable connected)
10. Programmable Binary Input #3 (Fault Reset)
11. Programmable Binary Input #4 (Unused)
12. Programmable Binary Input #5 (Engine Mounted Stop Button)

The controls system interfaced to the drive unit may need some external (external to the drive) programmed logic. Dzero has added two external interlocks that will shut the drive down using the drive run/stop control signal.

The external interlocks are:

1. North and South Mycom Compressors off.
2. Heat Exchanger high pressure less than 50 PSIG.

These two interlocks will prevent the engines from dumping Helium gas back into the suction header when there are no compressors running or pulling a vacuum when the supply gas is isolated from the refrigerator.

V TACHOMETER FEEDBACK AND SCALING

The Wet and Dry engines both have a tachometer attached to the drive shaft of the motor. The SIMOREG drive has the capability to estimate the motor speed based on motor EMF’s. Tachometer feedback to the drive is preferable because, as the mechanical load changes torque and polarity, this method may be somewhat unreliable.

The SIMOREG drive has dedicated and programmable tachometer inputs. It can accept a DC Tachometer input or an encoder (pulsed) Tachometer input. The SIMOREG drive doesn’t accept an AC Tachometer directly.

The Wet engine’s tachometer has a DC output of 0 to 98.7 Volts for speeds of 0 to 1000 RPM. Simply connect the + output to terminal 62 and the - output to terminal 60. Then program in the proper parameters listed in the Wet engine programming section.

The dry engine’s tachometer has an AC output of 18 pulses per revolution and 90 VRMS for speeds of 0 to 1000 RPM’s. This AC signal must be rectified with a simple bridge rectifier and divider circuit.

See the attached schematic for details. The + input then is input into terminal 61 and the - signal is input into terminal 60. The drive then is programmed to integrate this input for 10 ms. This integration stabilizes the tachometer signal while still leaving it responsive. Dzero found that if you over filter the bridge rectifier signal (a long time constant), that the drive has internal programming that senses the slow tachometer signal response and will trip the drive off on a fault. It's much better to use a small time constant and program the drive to integrate the tachometer signal.

VI SIMOREG PROGRAMMING

Each drive can be programmed using the keypad on the drive or through a serial port using software such as PC-INN from Siemens. The serial port is by far the easiest way. PC-INN dumps a text file from the computer into the drive through the serial port. When programming the drive for a CTI installation it's recommended that you obtain a copy of the program from Dzero and download it.

Programming the drive requires setting the 971 parameters to an assigned value based on its function. Some parameters require a connector number. A connector is a number assigned to a specific value or variable. There are 394 possible Connectors available. The SIMOREG manual lists the connector assignments.

The drive is capable of running several self tuning routines. These should only have to be run once. The tuning variables are saved along with the program when the program is saved to a text file.

Even though there are many parameters and connectors, programming the drive is relatively simple. Many of the parameters are set during self tuning and others are not used in the CTI application.

Steps to program the SIMOREG drive

1. Configure the 13 physical jumpers.
2. Program P-51 to load the default Parameters.
3. Download the appropriate text file through PC-INN

The following is a list of the available parameter groups used in programming the SIMOREG DC variable speed drive.

PARAMETER GROUP SUMMARY

P0-P50	Display Parameters
P51-P56	Access Authorization
P60-P67	Operator Panel Configuration
P70-P78	Drive Controller Rating
P80-P94	Drive Control Selections
P96-P99	Adjustable Fixed Setpoints
P100-P139	Motor Definition
P140-P144	Pulse Encoder Definition
P145-P148	Optional Motor Interface Definition
P150-P160	Armature Current Control Adjustments
P171-P184	Armature Current and Torque Limiting
P200-P205	Speed Controller Feedback Limiting
P220-P229	Speed Controller Adjustments
P250-P258	Field Current Controller Adjustments
P273-P277	EMF Voltage Controller Adjustments
P300-P302	Ramp Function Generator Adjustments
P303-P306	Ramp Generator Parameter Set 1 Adjustments
P307-P310	Ramp Generator Parameter Set 2 Adjustments
P311-P314	Ramp Generator Parameter Set 3 Adjustments
P315-P320	Speed Reference Limiting Adjustments
P351-P369	Monitoring Adjustments

P370-P396 Limit Value Adjustments
P401-P419 Reference Input Adjustments
P420-P433 Technology Controller Adjustments
P450-P452 Maximum Speed Calibration
P460-P466 Motor Potentiometer Adjustments
P470-P471 Tension/Ratio Control Adjustments
P480-P483 Speed Reference Function
P500 Current Reference Selection
P520-P530 Friction Compensation Adjustment
P540-P546 Inertia Compensation Adjustment
P550-P561 Speed Controller Adaptation Function Adjustments
P600-P607 Current/Torque Functions
P608-P609 Speed Controller Functions
P610-P616 Field and EMF Control Functions
P620-P629 Configuring the Ramp Generator
P630-P634 Configuring the Technology Controller
P635 Configuring the Acceleration Compensation Source
P640-P642 Configuring the Converter Control Word
P650-P699 Freely Defined Function Block Parameters
P700-P724 Analog Inputs
P739-P759 Analog Outputs
P761-P769 Binary Inputs
P770-P778 Binary Outputs
P780-P798 Drive Controller Serial Interface
P840-P849 Diagnostic Trace Buffer
P850-P855 Disable Faults and Spontaneous Messages
P860-P883 Diagnostic Trace Buffer Functions
P884-P887 Internal Converter Adjustments
P900-P971 Option Board Setup Parameters

VII PURCHASED DRIVE COMPONENETS

The following is a list of components with which a complete drive system can be assembled. The list includes the breaker protection and power disconnects needed to meet the NEC electrical code power requirements for the drive units. There is one disconnect not shown that is required for the power isolation transformer. The drive units themselves must be placed inside of a NEMA rated enclosure.

Each drive has a modest operator panel and push buttons mounted on the drive, however, it is recommended to use the add on LCD operator panel shown below. This operator panel allows monitoring and programming the drive from the front of the drive enclosure. It also has the stop/start/reset drive control buttons built into it.

The blue and red power plugs connecting the Engine motor to the flexible SO type power cord can be obtained from the Accelerator engine group.

1) 1 Siemens 2 HP Adjustable Speed DC Drive System, Four Quadrant Regenerative Drive.
Part# 6RA2413-2FV62 $3823
2) 1 Siemens 7.5 HP Adjustable Speed DC Drive System, Four Quadrant Regenerative Drive.
Part# 6RA2418-2FV62 $3984
3) 2 LCD Operator Panel Part #LCD2401L $304
4) 2 36” Cable for Operator Panel $44
5) 1 Circuit Breaker Kit for 2 HP, 25 Amp. Part #CB3402L $211
6) 1 Circuit Breaker Kit for 7.5 HP, 60 Amp. Part #CB3403L $211
7) 1 Line Reactor Kit for 2 HP. Part #LR22401L $128
8) 1 14KVA Isolation Transformer, 460 VAC Primary, 230 VAC Secondary. Part # T425S $809

9) 2 ITE 36″ Breaker Operator Cable. Part #FHOEO36 $197
10) 2 NEMA 12 Enclosure (30″ x 26″ x 12″) Part #SDN12-302612 $274
11) 2 Enclosure Subpanel (27″ x 21″) Part #NP-3024 $36
12) 4 Louver Kit. Part #WA-VK88 $13
13) 4 Louver Air Filter Kit. Part #WA-FLT 88 $14
14) 2 Locking Latch Kit. Part# WA-L2B $34

These parts can be ordered from Steiner Electric who is the local sales representative for Siemens Automation.
Steiner Electric Company
1250 Touhy Ave.
Elk Grove Village, Ill. 60007
847-228-0400
Sales Contact for Fermilab: Al Wong

VIII REPAIR AND SERVICE

Temporary loss of the of the Wet Engine normally is not an immediate problem because the JT valve is in parallel with the Wet Engine. The JT valve is a little less efficient than the engine, however most of the time using the JT valve will buy time until a repair can be made.

Temporary loss of the Dry Engine is a much more serious matter for the Helium refrigerator. Most refrigerators must be shutdown without the Dry Engine because of the loss of normal temperature equilibrium throughout the refrigerator heat exchangers. The Dry engine also seems to have a higher frequency of failure than the Wet engine.

The installation of these drives are the first of their kind at Fermilab. Dzero has taken some basic precautions to help assure that the engines will not be down for a relatively long time due to a drive failure. These precautions are stocking spare parts and a Siemens drive 24 hour repair service number

The spare parts stocked by Dzero include a power board, logic board, and fuses. Both drives have a power board and logic board in common, Dzero currently stocks one of each board. Dzero has purchased multiple complete sets of both power fuses and control fuses.

The Siemens drive 24 repair service number is 1-800-241-4453. This number will likely be used for a power thyrister failure or some other component not on either of the two electronic boards.

The Emergency Spare Parts Phone number is 1-770-740-3535. To contact after hours personnel advise the operator that you need the Drive Products Group (Account 3492).

Daytime Technical Assistance 1-770-740-3520, 1-770-740-3523, 1-770-740-3585.

It’s possible that these Siemens drives may be used in other refrigerators around the lab. If this becomes the case, it is possible the drive support would adjust accordingly. Siemens has a 1 week class that drive users may attend.

IX TEST RUN RESULTS AND FUTURE MODIFICATIONS

The entire Dzero Helium refrigerator and all it’s components were given a test run in June of 1997. The engines and their new drives ran approximately 1 week for 24 hrs a day during the two week testing period. The Siemens DC drives ran flawlessly under many conditions, loads, speeds, and temperatures during this time.

Both internal interlocks (programmed into the drive) and external interlocks (programmed into the PLC) were tested. All interlocks shut down the drives as expected.

The older GE drives have always been susceptible to RF interference from 2-way radios which would generally blow a number of fuses in the drive when a 2-way radio was keyed within 20’ of the drive. The Siemens drives were tested while running by keying 2 way radios around the drive and the DC motors on the engines at point blank range. The Siemens drives had no reaction to the RF and continued to work properly.

There are a few improvements which will be made in the future to the Siemens DC drive installations at Dzero. They are:

1. Status LED’s for the interlocks will be added to the enclosure front panel.
2. The drive may be programmed to hold the speed for a few seconds after the stop command is issued to reduce the chance of a slight acceleration in speed before shutdown. This is due to the time it takes for the inlet valve to close.

X CONCLUSION

The Siemens SIMOREG DC drive is one of many industrial drives that could be used with the current Fermilab Wet and Dry engine configuration. The field of usable drives was narrowed by the fact that one of the constraints was the wet and dry engine skids were not modifiable, i.e. changing the type of motor. The SIMOREG drive has many more features and capabilities than is needed for this application, such as thread, jog, torque mode Vs speed mode, etc.

One significant consideration I would like to point out for an engineer considering the installation of a modern DC drive is the support. Today, Dzero has the only installed SIMOREG drive at Fermilab. Dzero has taken the precautions it deems necessary to cover it’s own installation. Dzero is willing to consult with and support other installations, however, at this point Dzero is not the support center for this equipment at Fermilab.

Dzero recommends using the SIMOREG drive to anyone with the same requirements outlined in this memo. The SIMOREG is rugged, flexible, and a compact programmable modern DC drive. The SIMOREG performed extremely well and fills in some of the shortcomings of the older GE drives.

XI BIBLIOGRAPHY AND REFERENCE MATERIAL

1997 National Electric Code
National Fire Protection Ass.

1995 SIMOREG 6RA24 Installation Manual
Siemens A1-116-008-001 REV 4

1994 SIMOREG 6RA24 Quick Start Instructions
Siemens REV 4

3823 000 ED 33000845 D0 Collider System Dry Engine Wiring Diagram
Fermilab Drawing Dan Markley

3823 000 ED 33000846 D0 Collider System Wet Engine Wiring Diagram
Fermilab Drawing Dan Markley

Questions or comments may be E-MAILED to DMARKLEY@FNAL.GOV.

Appendix A: Wet Engine Motor Specifications

Horse Power: 2
Max RPM:1750
Armature Voltage: 140 Volts DC
Armature Amps: 13
Field Amps: .48
Winding Type: Shunt
Field ohms @ 25C: 299
Insulation: Class F
Rated for Continuous Duty
Max Ambient Temp: 40 C
Field Voltage: 200
Enclosure Type: DPFG
Model # 5CD144ME003B001.

Appendix B: Wet Engine Tachometer Specifications

Manufacturer: GE
Model #5PY59JY1
Max RPM: 2500
Output: 98.7 VDC per 1000 RPM.

Appendix C: Wet Engine Siemen's Variable Speed Drive Specifications

Siemens SIMOREG Microprocessor Variable Speed DC Drive
Type: 6RA2413-2FV62
Part#: A1-116-250-503
Instruction Book#: A1-116-008-001
Max Input: 460/230 VAC, +10%, -5%, 3 Phase
15 Amp AC
50 or 60 Hz
Max Output: 500/240 VDC
15 Amps DC
150 % Overload up to 1 minute
Shunt Field 300/150 VDC, 2.5 Amps DC

Appendix D: Dry Engine Motor Specifications

Horse Power:7.5
Max RPM: 1750
Armature Voltage: 240 Volts DC
Armature Amps: 26.5
Winding Type: Shunt
Field Amps: 2.4
Field Ohms @ 25C: 36
Insulation Rating Class F
Rated for Continuous Duty
Max Ambient Temp: 40 C
Field Volts: 120
Enclosure Type: DPFG
Model # 5CD145UC006B002.

Appendix E: Dry Engine Tachometer Specifications

Type: AC Tachometer
Output:45 RMS Volts per 1000 RPM @ T1-T2,
Output:90 RMS Volts per 1000 RPM @ T1-T3,
Output:18 cycles per revolution.

Appendix F: Dry Engine Siemen's Variable Speed Drive Specifications

Siemens SIMOREG Microprocessor Variable Speed DC Drive
Type: 6RA2418-2FV62
Part#: A1-116-250-504
Instruction Book#: A1-116-008-001
Max Input: 460/230 VAC, +10%, -5%, 3 Phase
30 Amp AC
50 or 60 Hz
Max Output: 500/240 VDC
30 Amps DC
150 % Overload up to 1 minute
Shunt Field 300/150 VDC, 5 Amps DC

Drive Programmable I/O

Analog Inputs
- Speed Ref Term 4,5
- #1 Unused Term 6,7
- #2 Unused Term 8,9
- #3 Unused Term 10,11

Analog Outputs
- Arm Current Term 12,13
- #1 Speed(RPM) Term 14,15 K149
- #2 Torque(dV/dT) Term 16,17 K150
- #3 # of Last Fault Term 18,19 K337
- #4 Unused Term 20,21

Binary Inputs
- On/Off Term 37 Closes Contactor and runs if 38 is also on
- Enable Term 38 Runs Regulator if 37 is on
- Fault Acknowledge Term 36
- #1 Over Speed Limit Switch Term 39 BIF4 "Quick Stop"
- #2 Tach Cable Connected Term 40 BIF4 "Quick Stop"
- #3 Term 41 BIF 5 "Fault Reset"
- #4 Unused Term 42
- #5 Stop Button on Enginr Term 43 BIF 4 "Quick Stop"

Binary Outputs
- #1 "NO Fault" Term 46 BOF3
- #2 "Run" Term 48 BOF6
- #3 "Ready to Start" Term 50 BOF4
- #4 Unused Term 52

Jumpers
- XJ1 Position 1-2 EEPROM Write Enable
- XJ9 Position 1-2 Common for Binary input not tied to M
- XJ10 Position 2-3 Binary Output Supplied from External 24V

Note: All RD Wet engines are considered interchangable. Dzero interconnections to the Wet engine maintain this RD Policy.

480 VAC 3 Phase Feed

14 KVA Isolation Transformer

L1 L2 L3

PLC Output 0-10 VDC Speed Setpoint

+ WY3178 –

2 P10
4 Ref +
5 Ref -
1 Com

PLC Discrete Outputs

Y3197 BLUE
Y3198 VIOLET
Y3199 GRAY
Y3200 WHITE

37 Run
38 Reg Enable
41 Prog #3
42 Prog #4
39 Prog #1
40 Prog #2
43 Prog #5

Digital Inputs

Analog Outputs

Armature Current 12 13
Prog#1 14 15
Prog#2 16 17
Prog#3 18 19
Prog#4 20 21

WX3221
WX3222
WX3223
WX3224

PLC Analog Input Modules

Engine J.B.

Em Stop
O.S. Brake
Motor Temp
A
B

1 BLK A
2 BRN B
3 RED C
4 ORG D
5 YEL E
6 GRN F
7 BLU G
8 VIO H
9 GRAY J
10 WHT K
11 BLK/S L
12 BRN/S M
13 ORG/S N
14 RED/S P
15 R
16 S

Hr Meter
Purge
Purge
DC Tach
T1 C + D –
T3 A C

Motor Fan
115 VAC .42 Amps

Inlet Valve

Common

Frequency to DC Converter
30k
30k 1800pF

56 Emergency Stop
62 +Tach Input
64 Tach Common

Siemens 7.5 HP 4 Quadrant DC Adjustable Speed Drive

M
89 87 90 91 A1+ A2- +80 -81

Ext 24VDC 49
Common 47
Common 45
"No Fault" 46
Prog#2 48
Prog#3 50
Prog#4 52

RED +24VDC FROM PLC
BLACK COMMON FROM PLC
BROWN X3213
ORANGE X3214
YELLOW X3215
GREEN X3216

PLC Digital Inputs

X300

Operator Display Mounted in Door

Shunt Field
Motor
S1 S2 A1 A2

Components

1. Siemens 14KVA Isolation Transformer. 460VAC Primary. 230VAC Secondary. Part# T425S
2. Bridge Rectifier and Filter. Use With 10 ms Integrattion programmed in Drive.
3. Siemens 7.5 HP Adjustable Speed DC Drive System. Four Quadrant. Regenerative. Part#6RA2418-2FV62
4. Hoffman NEMA 12 Enclosur. 30"x26"x12". Part#A30SA2612LP.
5. Siemens Circuit Breaker Kit for 7.5HP. 60 Amp. Pat#CB2403L.
6. Siemens LCD Operator Panel. Part# LCD2401L. Mounted in the door of item 4.
7. GE 7.5HP Kinematic DC Motor. 1750RPM. 240Volts. Armature 26.5 Amps. Field volts 120. Field Amps 2.4. Mod#5CD145UC006B002.
8. GE Tachometer. 90 VAC per 1000 RPM. Model# GEH 3252B. 18 Cycles per Revolution.

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.

PARTS LIST

UNLESS OTHERWISE SPEC.			ORIGINATOR	Dan Markley	6/6/96
FRACTIONS	DECIMALS	ANGLES	DRAWN	Dan Markley	6/6/96
			CHECKED	Dan Markley	8/22/96
			APPROVED		
			USED ON		
			MATERIAL–		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

D0 Collider Helium System
DRY Engine Wiring Diagram

SCALE	FILMED	DRAWING NUMBER	REV.
		3823 000 ED 330085	A

Drive Programmable I/O

Analog Inputs
- Speed Ref Term 4,5
- #1 Unused Term 6,7
- #2 Unused Term 8,9
- #3 Unused Term 10,11

Analog Outputs
- Arm Current Term 12,13
- #1 Speed(RPM) Term 14,15 K149
- #2 Torque(dV/dT) Term 16,17 K150
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- #4 Unused Term 42
- #5 Stop Button on Engine Term 43 BIF 4 "Quick Stop"

Binary Outputs
- #1 "NO Fault" Term 46 BOF3
- #2 "Run" Term 48 BOF6
- #3 "Ready to Start" Term 50 BOF4
- #4 Unused Term 52

Jumpers
- XJ1 Position 1-2 EEPROM Write Enable
- XJ9 Position 1-2 Common for Binary input not tied to M
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480 VAC 3 Phase Feed

① 14 KVA Isolation Transformer

② Line Reactor

L1 L2 L3

③

④

⑤

PLC Output 0-10 VDC Speed Setpoint
+ WY3177
–
2 P10
4 Ref +
5 Ref -
1 Com

PLC Discrete Outputs
Y3193 BLUE
Y3194 VIOLET
Y3195 GRAY
Y3196 WHITE
37 Run
38 Reg Enable
41 Prog #3
42 Prog #4
39 Prog #1
40 Prog #2
43 Prog #5
Digital Inputs

Analog Outputs
Armature Current 12 13
Prog#1 14 15
Prog#2 16 17
Prog#3 18 19
Prog#4 20 21
WX3217
WX3218
WX3219
WX3220
PLC Analog Input Modules

Engine J.B.

Em Stop
D.S. Brake
A
B
1 BRN A
2 RED B
3 ORG C
4 YEL D
5 GRN E
6 BLUE F
7 VIO G
8 GRAY H
9 WHT J
10 BLK K
11 BRN/S L
12 RED/S M
13 ORG/S N
14 YEL/S P
15 GRN/S R
16 BLK/S S

Hr Meter
Purge
Purge
DC Tach
⑧
C +
D –

Motor Fan
115 VAC .42 Amps
A
C

Inlet Valve

56 Emergency Stop
60 +Tach Input
64 Tach Common

Siemens 2HP 4 Quadrant DC Adjustable Speed Drive

M
89 87 90 91 A1+ A2- +80 -81

Ext 24VDC 49
Common 47
Common 45
"No Fault" 46
Prog#2 48
Prog#3 50
Prog#4 52
RED +24VDC from PLC
BLACK Common from PLC
BROWN X3209
ORANGE X3210
YELLOW X3211
GREEN X3212
PLC Digital Inputs

X300
Operator Display Mounted in Door
⑥

Common

Shunt Field
Motor
⑦

Components

1. Siemens 14KVA Isolation Transformer. 460VAC Primary. 230VAC Secondary. Part# T425S
2. Siemens 2HP Line Reactor Kit. Part# LR22401L.
3. Siemens 2HP Adjustable Speed DC Drive System. Four Quadrant. Regenerative. Part#6RA2413-2FV62
4. Hoffman NEMA 12 Enclosur. 30"x26"x12". Part#A30SA2612LP.
5. Siemens Circuit Breaker Kit for 2HP. 25 Amp. Part#CB2402L.
6. Siemens LCD Operator Panel. Part# LCD2401L. Mounted in the door of item 4.
7. GE 2HP Statotrol DC Full Wave Motor.1750RPM. 140Volts. Armeture 13 Amps. Field volts 200. Field Amps .48. Mod#5CD144ME003B001.
8. GE Tachometer. 98.7 VDC per 1000 RPM. Model# 6PY59JY1. 2500 Max RPM.

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.

PARTS LIST

UNLESS OTHERWISE SPEC.			ORIGINATOR	Dan Markley	4/19/96
FRACTIONS	DECIMALS	ANGLES	DRAWN	Dan Markley	4/19/96
			CHECKED	Dan Markley	8/20/96
			APPROVED		
			USED ON		
			MATERIAL-		

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UNITED STATES DEPARTMENT OF ENERGY

D0 Collider Helium System Wet Engine Wiring Diagram

SCALE	FILMED	DRAWING NUMBER	REV.
		3823 000 ED 330086	A

Drive Programmable I/O

Analog Inputs
- Speed Ref Term 4,5
- #1 Unused Term 6,7
- #2 Unused Term 8,9
- #3 Unused Term 10,11

Analog Outputs
- Arm Current Term 12,13
- #1 Speed(RPM) Term 14,15 K149
- #2 Torque(dV/dT) Term 16,17 K150
- #3 # of Last Fault Term 18,19 K337
- #4 Unused Term 20,21

Binary Inputs
- On/Off Term 37 Closes Contactor and runs if 38 is also on
- Enable Term 38 Runs Regulator if 37 is on
- Fault Acknowledge Term 36
- #1 Over Speed Limit Switch Term 39 BIF4 "Quick Stop"
- #2 Tach Cable Connected Term 40 BIF4 "Quick Stop"
- #3 Term 41 BIF 5 "Fault Reset"
- #4 Unused Term 42
- #5 Stop Button on Enginr Term 43 BIF 4 "Quick Stop"

Binary Outputs
- #1 "NO Fault" Term 46 BOF3
- #2 "Run" Term 48 BOF6
- #3 "Ready to Start" Term 50 BOF4
- #4 Unused Term 52

Jumpers
- XJ1 Position 1-2 EEPROM Write Enable
- XJ9 Position 1-2 Common for Binary input not tied to M
- XJ10 Position 2-3 Binary Output Supplied from External 24V

Note: All RD Wet engines are considered interchangable. Dzero interconnections to the Wet engine maintain this RD Policy.

480 VAC 3 Phase Feed

14 KVA Isolation Transformer

L1 L2 L3

PLC Output 0-10 VDC Speed Setpoint

+ WY3178 –

2 P10
4 Ref +
5 Ref -
1 Com

PLC Discrete Outputs

Y3197 BLUE
Y3198 VIOLET
Y3199 GRAY
Y3200 WHITE

37 Run
38 Reg Enable
41 Prog #3
42 Prog #4
39 Prog #1
40 Prog #2
43 Prog #5

Digital Inputs

Analog Outputs

Armature Current 12 13
Prog#1 14 15
Prog#2 16 17
Prog#3 18 19
Prog#4 20 21

WX3221
WX3222
WX3223
WX3224

PLC Analog Input Modules

Engine J.B.

Em Stop
O.S. Brake
Motor Temp
A
B

1 BLK A
2 BRN B
3 RED C
4 ORG D
5 YEL E
6 GRN F
7 BLU G
8 VIO H
9 GRAY J
10 WHT K
11 BLK/S L
12 BRN/S M
13 ORG/S N
14 RED/S P
15 R
16 S

Hr Meter
Purge
Purge
DC Tach
T1 C + D –
T3 A C

Motor Fan
115 VAC .42 Amps

Inlet Valve

Common

Frequency to DC Converter
30k
30k 1800pF

56 Emergency Stop
62 +Tach Input
64 Tach Common

Siemens 7.5 HP 4 Quadrant DC Adjustable Speed Drive

M
89 87 90 91 A1+ A2- +80 -81

Ext 24VDC 49
Common 47
Common 45
"No Fault" 46
Prog#2 48
Prog#3 50
Prog#4 52

RED +24VDC FROM PLC
BLACK COMMON FROM PLC
BROWN X3213
ORANGE X3214
YELLOW X3215
GREEN X3216

PLC Digital Inputs

X300

Operator Display Mounted in Door

Shunt Field
Motor
S1 S2 A1 A2

Components

1. Siemens 14KVA Isolation Transformer. 460VAC Primary. 230VAC Secondary. Part# T425S
2. Bridge Rectifier and Filter. Use With 10 ms Integrattion programmed in Drive.
3. Siemens 7.5 HP Adjustable Speed DC Drive System. Four Quadrant. Regenerative. Part#6RA2418-2FV62
4. Hoffman NEMA 12 Enclosur. 30"x26"x12". Part#A30SA2612LP.
5. Siemens Circuit Breaker Kit for 7.5HP. 60 Amp. Pat#CB2403L.
6. Siemens LCD Operator Panel. Part# LCD2401L. Mounted in the door of item 4.
7. GE 7.5HP Kinematic DC Motor. 1750RPM. 240Volts. Armature 26.5 Amps. Field volts 120. Field Amps 2.4. Mod#5CD145UC006B002.
8. GE Tachometer. 90 VAC per 1000 RPM. Model# GEH 3252B. 18 Cycles per Revolution.

ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.

PARTS LIST

UNLESS OTHERWISE SPEC.			ORIGINATOR	Dan Markley	6/6/96
FRACTIONS	DECIMALS	ANGLES	DRAWN	Dan Markley	6/6/96
			CHECKED	Dan Markley	8/22/96
			APPROVED		
			USED ON		
			MATERIAL–		

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D0 Collider Helium System
DRY Engine Wiring Diagram

SCALE	FILMED	DRAWING NUMBER	REV.
		3823 000 ED 330085	A

Drive Programmable I/O

Analog Inputs
- Speed Ref Term 4,5
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- #2 Unused Term 8,9
- #3 Unused Term 10,11

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- Arm Current Term 12,13
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- #3 Term 41 BIF 5 "Fault Reset"
- #4 Unused Term 42
- #5 Stop Button on Engine Term 43 BIF 4 "Quick Stop"

Binary Outputs
- #1 "NO Fault" Term 46 BOF3
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480 VAC 3 Phase Feed

① 14 KVA Isolation Transformer

② Line Reactor

L1 L2 L3

③

④

⑤

PLC Output 0-10 VDC Speed Setpoint
+ WY3177
–
2 P10
4 Ref +
5 Ref -
1 Com

PLC Discrete Outputs
Y3193 BLUE
Y3194 VIOLET
Y3195 GRAY
Y3196 WHITE
37 Run
38 Reg Enable
41 Prog #3
42 Prog #4
39 Prog #1
40 Prog #2
43 Prog #5
Digital Inputs

Analog Outputs
Armature Current 12 13
Prog#1 14 15
Prog#2 16 17
Prog#3 18 19
Prog#4 20 21
WX3217
WX3218
WX3219
WX3220
PLC Analog Input Modules

Engine J.B.

Em Stop
D.S. Brake
A
B
1 BRN A
2 RED B
3 ORG C
4 YEL D
5 GRN E
6 BLUE F
7 VIO G
8 GRAY H
9 WHT J
10 BLK K
11 BRN/S L
12 RED/S M
13 ORG/S N
14 YEL/S P
15 GRN/S R
16 BLK/S S

Hr Meter
Purge
Purge
DC Tach
⑧
C +
D –

Motor Fan
115 VAC .42 Amps
A
C

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56 Emergency Stop
60 +Tach Input
64 Tach Common

Siemens 2HP 4 Quadrant DC Adjustable Speed Drive

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89 87 90 91 A1+ A2- +80 -81

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Operator Display Mounted in Door
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Shunt Field
Motor
⑦

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			USED ON		
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D0 Collider Helium System Wet Engine Wiring Diagram

SCALE	FILMED	DRAWING NUMBER	REV.
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