DCSi-PRO / DCSi-LITE:

ESP Power Optimizer,

Power Plus Optimizer,

Power Plus DSP,

Chopper Optimizer

Users Guide

Revision: 3.7.1

Date: 2/27/06

Revisions

Rev.	Date	Author	Description
1.0	11/15/00	I. Chebruch	Draft
1.1	11/27/00	I.Chebruch	Changed Format
1.2	12/08/00	I.Chebruch	**GVC:** set the ranges for Pri. Voltage Limit, Sec. Voltage Limit, Sec. Current Limit, and UV delay according to GVC Controller software version
1.3	01/02/01	I. Chebruch	**Power Plus:** added IE ms OFF Holding register
1.4	02/05/01	I. Chebruch	**Chopper:** 30014 (addr. 10) and so on: added Full Duty Cycle Status and Fuse Process active to Note 2.
1.5	02/06/01	I. Chebruch	**Chopper and Power Plus:** changed the range for Undervoltage delay to 5 – 45 sec.
1.6	06/27/01	R. Zara	**Chopper:** Added input Reg 30040 for Bus Power
1.7	08/21/02	R. Zara	**ALL:** Added BOLD/shading to depict LITE version registers
1.8	04/21/04	R. Zara	**ALL:** Added DCSi Uptime counters 39603-604
1.9	04/22/04	R. Zara	Redefined register 49601 DCSi Reset to activate a reset by writing a 1 via function code 06, previously it was activated by reading via function code 03
2.0	06/29/04	R. Zara	**All:** Reformatted User Guide. Limited Function 16 to a maximum of 10 registers per request. **Chopper:** Added Holding Reg 40075 Fuse Count **GVC/PowerPlus:** Eliminated DVC holding Register Info
3.0	11/09/04	R. Zara	**Added Device type PowerPlus DSP** **All:** All input registers available in Lite version
3.1	11/19/04	R. Zara	**P+/P+DSP:** Reg 40007 changed from Manual Mode Duty Cycle to Spare
3.2	12/01/04	R. Zara	**All:** Corrected ranges for Clear Alarm reg 40169 Corrected column alignment for 'Range' & 'Units' columns regs 30023-30034
3.3	12/29/04	R. Zara	**All:** Eliminate Holding Reg 40028, was 'Max Cur Cond' **P+ & P+DSP:** Eliminated Hold Reg 40177 ' Fan Pwr Save' **P+DSP:** Eliminated Back Corona Settings 40021-24
3.4	01/13/05	R. Zara	**All:** Added definitions of SW1-8, 9 & 10 **All:** Added DCSi One Line Communication Diagram **All:** Added Apendix A & B
3.4.1	01/20/05	R. Zara	**All:** Define register Scanning rates; Minor Clarifications
3.5	05/02/05	J. Stevenson	**All:** DIP switch settings and other minor clarifications
3.6	01/16/05	J. Stevenson	**All:** Corrected Modbus slave address range described in 5.2 **All:** Added Note 11 to holding registers
3.7	02/20/06	J. Stevenson	**All:** Identified write-only holding registers **Chopper:** Changed several holding registers to spare
3.7.1	02/27/06	J. Stevenson	**All:** Changed Input Reg. Update Rate to 1 Sec. in Section 5.3.5 Added System Input Register 39999 to show the DCSi firmware revision number

Table of Contents

1. Introduction

This document defines the NWL Transformers Distributed Control Systems Interface (DCS*i*) Module for use with NWL's Optimizer Family Controllers. The DCS*i* Module will serve as an interface between NWL's ESP Power Optimizer™ and Plant Distributed Control Systems (DCS) using Modbus RTU or ASCII protocol.

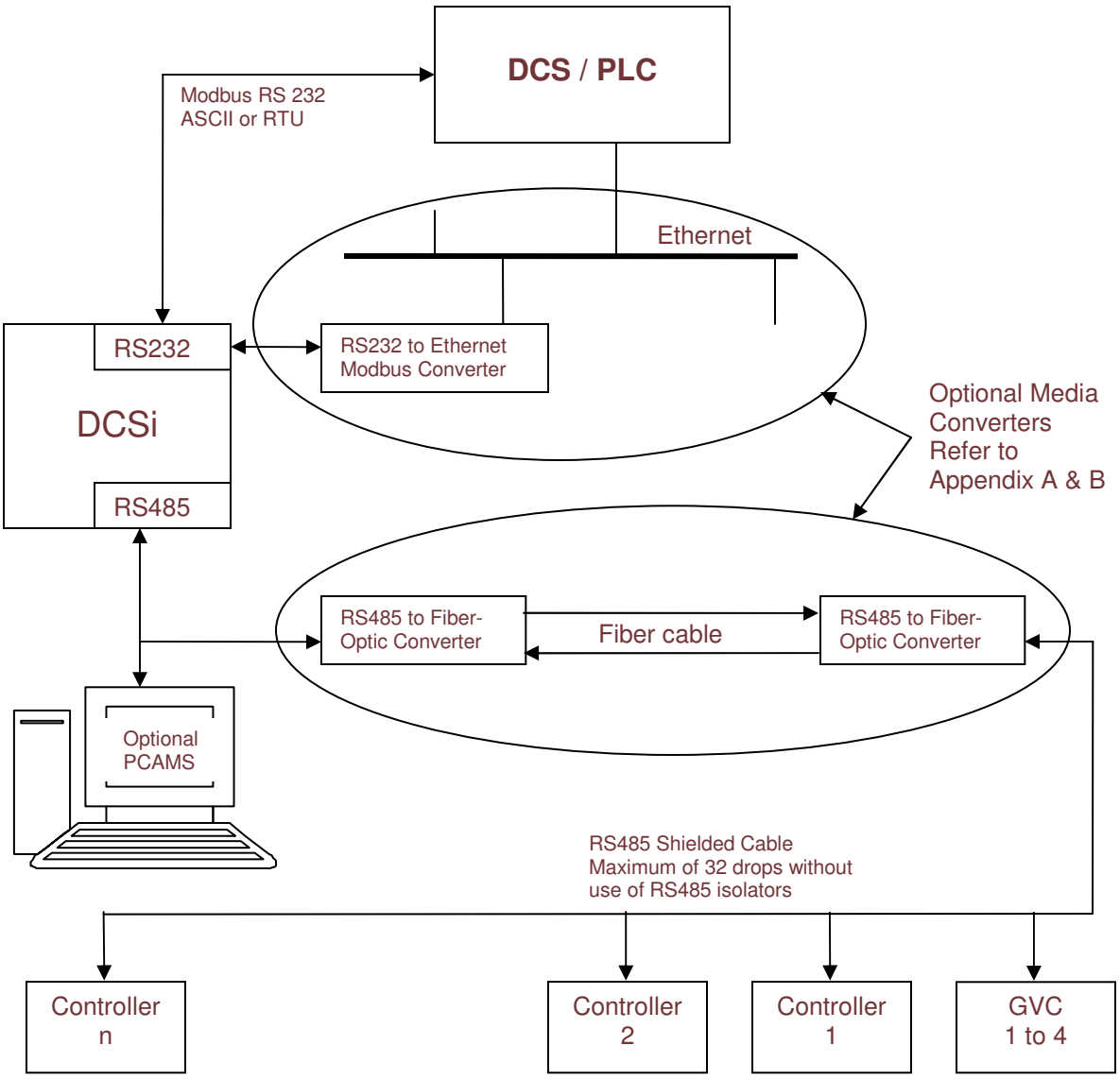
2. Acronyms/Definitions

DCSi	Distributed Control System Interface – The DCSi will provide an interface between a plant's distributed control system Modbus link and the NWL Optimizer/DSP Controller communication link.
GVC	Graphical Voltage Controller – Keypad/Display Module – Hand-held user interface used to monitor and program the Optimizer boards
ESP Power Optimizer	Microprocessor Controller for controlling SCR type Precipitator Power supplies
PowerPlus Optimizer	Microprocessor Controller for controlling High Frequency type Precipitator Power supplies
PowerPlus DSP	Microprocessor Controller for controlling High Frequency type Power supplies utilizing a DSP Processor with High Speed Sampling.
Chopper Optimizer	Microprocessor Controller for controlling Medium Frequency type Power supplies

3. Design Overview

The DCSi has two communication ports. Port 1 will communicate to the DCS system using either Modbus ASCII or Modbus RTU utilizing RS232. Port 2 will communicate to the Optimizer network utilizing RS485. The DCSi/Optimizer link addressing scheme allows for 1 DCSi, 1 PCAMS, 4 GVCs, and 90 Optimizers. The communication link is limited to 32 of these devices. With the use of RS485 isolators the network can be expanded to the full range of addressing. A system block diagram is shown below:

3.1 DCSi One Line Communication Diagram



DCSi One Line Communication Diagram

4. Hardware

4.1 Micro/Sys SNAP 651-1

Micro/Sys SNAP 651-1 Communications Microcontroller Board with the following features:

Processor	Intel 80C31, 14 MHz clock
Communication Ports	1 RS485 using microcontroller UART 2 RS232 using Signetics 2692 DUART (1 unused)
Memory	64K x 8 EPROM 32K x 8 SRAM
Watchdog Timer	1.6 second reset timer
Parallel I/O	24 lines via 82C55A peripheral chip – used for configuration
Environment	0° - 70° C operating, 5% - 95% relative humidity, non-condensing

4.2 DCSi Power Supply/Terminal Module

NWL Transformers DCS*i* Power Supply/Terminal Module

Input	115 VAC ± 5%
Output	5 VDC ± 5% @ 250 mA
Environment	0° - 70° C operating, 5% - 95% relative humidity, non-condensing
Switches	8 or 10 position DIP switch for configuration
LED's	LED's showing link activity, communication link configuration

4.3 DCSi Connector Pin Assignments

The DCS*i* does not use hardware handshaking and only requires the TXD, RXD, and GND connections. ***The Plant DCS may require signals to be tied to specific voltage levels. Check your documentation for more information.***

Sample cable from Computer to DCS*i* (note the twist of pins 2 & 3)

9 Pin PC (AT) RS232 Serial Port		*connects to*	DCS*i, J7 or J8*
Pin 1	Carrier Detect (DCD)		
Pin 2	Receive Data (RXD)	————	Pin 3
Pin 3	Transmit Data (TXD)	————	Pin 2
Pin 4	Data Terminal Ready (DTR)		
Pin 5	Ground (GND)	————	Pin 5
Pin 6	Data Set Ready (DSR)		
Pin 7	Request to Send (RTS)		
Pin 8	Clear to Send (CTS)		
Pin 9	Ring Indicator (RI)		

RS485 Connector (J3) to ESP Power Optimizers

The Length, Type, and routing of RS485 cable can make or break a RS485 network. Please be sure to use RS485 certified cable, keep segment lengths to less than 4000 ft, and DO NOT route the cable along with or next to high current devices/cabling or other noise emitting sources. Refer to NWL Drawing B117136 Rev A for NWL recommended RS485 guidelines.

J3 Pin #	Description
1	High
2	Low
3	Signal Common

5. Functional Overview

5.1 Configuration

NWL Link	9600/19200 Baud (automatic detection) 8 data bits, 1 stop bit, no parity
DCS Link	19200/38400 Baud configurable Modbus RTU: 1 start bit, 8 data bits, parity and stop bits configurable Modbus ASCII: 1 start bit, 7 data bits, parity and stop bits configurable Modbus Slave Addresses configurable

5.2 82C55A Parallel I/O Configuration Bits

The 82C55A Parallel I/O Port A will be used for the DCS*i* configuration. Port A Bit 0 corresponds to DCS*i* Configuration Bit 0, etc. The bits will be configurable via switch SW1 on the DCS*i* Power Supply/Terminal Module. Bits 4 & 5 define the Slave Addresses 1-4, 5-8, 9-12, or 13-16. Bit 6 will select Modbus RTU or ASCII protocol.

SW1-1 Bit 0	DCS Link Baud Rate
On	19200
Off	38400

SW1-2 Bit 1	SW1-3 Bit 2	DCS Link Parity
On	On	None
On	Off	Even
Off	On	Odd
Off	Off	(unused)

SW1-4 Bit 3	DCS Link Stop Bits
On	1
Off	2

SW1-5 Bit 4	SW1-6 Bit 5	Modbus Slave Address
On	On	1 – 4
On	Off	5 – 8
Off	On	9 – 12
Off	Off	13 - 16

SW1-7 Bit 6	Protocol
On	Modbus RTU
Off	Modbus ASCII

SW1-8 Bit 7 **	Extended Registers *
On	Yes
Off	No

* - Note: Extended Registers refers to the Rotating Hammer Registers (Holding Registers 40083 -> 40146). If your application does not required this information SW1-8 should be set to the off position to increase bandwidth and scanning rate of remaining registers.

SW 1-9 **	RS485 Pull up
On	22K
Off	None

SW 1-10 **	RS485 Pull Down
On	22k
Off	None

**- Note: SW1 positions 8, 9 & 10 are only valid on units manufactured after Feb 2005.

5.3 Software

Programming the Plant's DCS to communicate with the NWL Transformers DCS*i* requires prior knowledge of the Modbus communications protocol. This section defines the Modbus register assignments utilized by the DCS*i* but does not discuss Modbus programming techniques.

The DCS*i* operates two (2) communications ports - 1 NWL Link, and 1 DCS Link. The NWL Link protocol and communication port parameters are automatically configured. The DCS*i* supports the Anti-collision protocol for the NWL Link.

5.3.1 Optimizer Recognition

The DCS*i* will scan the NWL Link after startup to determine the Optimizers that are on the link. Optimizers that do not respond will be re-checked for communications approximately every 10 minutes.

5.3.2 DCS Writes

When the DCS writes a value to the Optimizer via the DCSi, the DCSi will write the value followed by an immediate read. The value read will be updated in the Optimizer registers internal to the DCSi. This way, the DCS can read back the value (after a certain amount of delay), to determine if the value was accepted or rejected. If it was accepted, then the value will have been changed. If rejected, then the value would be the same as previous.

5.3.3 Supported Modbus Functions

Function #	Description	Register Range
3	Read Holding Registers	40001 - 50000
4	Read Input Registers	30001 - 40000
6	Preset Single Register	40001 - 50000
16	Preset Multiple Registers	40001 - 50000
17	Report Slave ID	n/a

5.3.4 DCSi Slave Type

The DCS*i* will report a Slave ID (function code 17) of 3 for a **Micro 584** Slave Type. The DCSi device has the following restrictions:

Function #	Maximum Registers per Query	Maximum Registers per Response
3	125	125
4	125	125
6	1	1
16	10	10

5.3.4.1 Modbus Slave Address

The Slave Address in combination with the Registers selected will determine which Controller is selected.

Modbus Slave Address	Controller Address Range
1, 5, 9, 13	10 - 33
2, 6, 10, 14	34 - 57
3, 7, 11, 15	58 - 81
4, 8, 12, 16	82 - 99*

* Controller Addresses above 99 are invalid

5.3.5 Input Registers

The input registers are for monitoring only. The DCS*i* continuously updates each Optimizers Input registers on a round robin basis. Input registers are scanned approximately every 1 second. Therefore each individual Optimizer's Input Registers will be updated per the following equation.

Input Reg Update Rate (Seconds) = Qty of Active Optimizers

Each Optimizer is assigned a block of input register numbers as shown below:

Register # Range	Optimizer Address
30001 – 30400	10
30401 – 30800	11
30801 – 31200	12
31201 – 31600	13
31601 – 32000	14
32001 – 32400	15
32401 – 32800	16
32801 – 33200	17
33201 – 33600	18
33601 – 34000	19
34001 – 34400	20
34401 – 34800	21
34801 – 35200	22
35201 – 35600	23
35601 – 36000	24
36001 – 36400	25
36401 – 36800	26
36801 – 37200	27
37201 – 37600	28
37601 – 38000	29
38001 – 38400	30
38401 – 38800	31
38801 – 39200	32
39201 – 39600	33
39601 – 40000	DCSi Status

The function of each register is shown in the following table. The register numbers in the table are for Optimizer address 10. By offsetting the register addresses in multiples of four hundred, other Optimizers are addressed.

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Power Plus	Power Plus DSP	Chopper	ESP…	Pwr. Plus	Pwr. Plus DSP	Chop.	ESP…	Pwr. Plus	Pwr. Plus DSP	Chop.
30001	10	Communication Status				0 – 1				Disabled/Enabled			
30002	10	Prim. Voltage	Line voltage			0 – 720				VAC			
30003	10	Prim. Current	Line current			0-750				AAC			
30004	10	Sec. Voltage1	KV	Sec. voltage		0 – 200				KVDC			
30005	10	Sec. Voltage2	Spare	KVpk	Spare	0-200	N/a	0-200	N/a	KVDC	N/a	KVDC	N/a
30006	10	Secondary Current				0 – 5000				mADC			
30007	10	Secondary Power				0 – 9999				KW x 10			
30008	10	Cond. Angle	Duty Cycle		Spare	0-160	0-100		N/a	deg	%		N/a
30009	10	Current cond.	Spare			0-180	N/a			deg	N/a		
30010	10	Spark rate				0-999				Sparks/min			
30011	10	Arc Rate	Spare	Arc Rate	Spare	0-99	N/a	0-99	N/a	Arc/min	N/a	Arc/min	N/a
30012	10	Contactor Status				0-1				Off, On			
30013	10	Alarm Status				0-24				See Note 1			
30014	10	Limit Status				0-8				See Note 2			
30015	10	Hammer 1 Status			Spare	0-1			N/a	Off,On			N/a
30016	10	Hammer 2 Status			Spare	0-1			N/a	Off,On			N/a
30017	10	Hammer 3 Status			Spare	0-1			N/a	Off,On			N/a
30018	10	Hammer 4 Status			Spare	0-1			N/a	Off,On			N/a
30019	10	Remote On Input Status				0-1				Off,On			
30020	10	Remote Enable Input Status				0-1				Off,On			
30021	10	Local/Remote Status				0-1				Local, remote			
30022	10	Pri.current x 10	Line current x 10			0-7500				AAC x 10			
30023	10	VAC Low Out of Range	Spare			0-1	N/a			No, Yes	N/a		
30024	10	VAC High Out of Range	Spare			0-1	N/a			No, Yes	N/a		
30025	10	AAC Low Out of Range	Spare			0-1	N/a			No, Yes	N/a		
30026	10	AAC High Out of Range	Spare			0-1	N/a			No, Yes	N/a		
30027	10	KVDC Low Out of Range	Spare			0-1	N/a			No, Yes	N/a		

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Power Plus	Power Plus DSP	Chopper	ESP…	Pwr. Plus	Pwr. Plus DSP	Chop.	ESP…	Pwr. Plus	Pwr. Plus DSP	Chop.
30028	10	KVDC High Out of Range	Spare			0-1	N/a			No, Yes	N/a		
30029	10	mADC Low Out of Range	Spare			0-1	N/a			No, Yes	N/a		
30030	10	mADC High Out of Range	Spare			0-1	N/a			No, Yes	N/a		
30031	10	KW Low Out of Range	Spare			0-1	N/a			No, Yes	N/a		
30032	10	KW High Out of Range	Spare			0-1	N/a			No, Yes	N/a		
30033	10	SPM High Out of Range	Spare			0-1	N/a			No, Yes	N/a		
30034	10	APM High Out of Range	Spare			0-1	N/a			No, Yes	N/a		
30035	10	Spare		Bus Voltage		N/a		0-700		N/a		VDC	
30036	10	Spare		Bus Current		N/a		0-500		N/a		ADC	
30037	10	Spare		Fan Current	Bus Current Ext	N/a		0-100	0-500	N/a		AAC * 10	ADC
30038	10	Spare		Heat Sink Temp.	Volt.ref DAC	N/a		0-99	0-102	N/a		Deg C	%
30039	10	Spare		IE ON Actual	Curr.Ref. DAC	N/a		1-200	0-110	N/a		mSec * 10	%
30040	10	Spare		IE OFF Actual	Bus Power	N/a		1-990	0-9999	N/a		mSec * 10	KW*10
:													
:													
30399	10	Device Type				1,2	3,4	9, 10	5,6,7,8	Local Port, Network Port			
30400	10	Device Address				10-99							
30401	11	Communication Status				0 – 1				Disabled/Enabled			
:													
:													
39600	33	Device Address				10-99							

5.3.6 System Input Register

The following registers are reserved for DCSi status information.

Reg#	Addr	Description	Range	Units
39601	N/a	NWL Link Communication Status	0-1	Disabled, Enabled
39602	N/a	DIP Switch Configuration	0-255	
39603	N/a	DCSi Uptime counter	0-65535	Seconds
39604	N/a	DCSi Uptime counter	0-65535	18.2 Hours
39605		Spare		
:				
39998		Spare		
39999		DCSi Firmware Version ID	0-999	Version x 10
40000		Spare		

5.3.7 Holding Registers

The holding registers can be read and written, except registers 40168 and 40169, which are write-only. The Holding Registers will be updated upon power-up of the DCS*i* and then on a round robin basis occurring every 6 seconds. Therefore each individuals Optimizer's Holding Registers will be updated per the following equation.

Holding Reg Update Rate (sec) = 6 * Qty of Active Optimizers

Each SCPU is assigned a block of holding register numbers as shown below:

Register # Range	Optimizer Address
40001 – 40400	10
40401 – 40800	11
40801 – 41200	12
41201 – 41600	13
41601 – 42000	14
42001 – 42400	15
42401 – 42800	16
42801 – 43200	17
43201 – 43600	18
43601 – 44000	19
44001 – 44400	20
44401 – 44800	21
44801 – 45200	22
45201 – 45600	23

45601 – 46000	24
46001 – 46400	25
46401 – 46800	26
46801 – 47200	27
47201 – 47600	28
47601 – 48000	29
48001 – 48400	30
48401 – 48800	31
48801 – 49200	32
49201 – 49600	33
49601 – 50000	DCSi Status

The function of each register is shown in the following table. The register numbers in the table are for Optimizer address 10. By offsetting the register addresses in multiples of four hundred, other Optimizers are addressed.

Note: All listed Registers are available in the PRO version of the DCSi. Only Registers that are listed in **BOLD with gray background** are available in the LITE version of the DCSi.

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	**Power Plus**	**Power Plus DSP**	**Chopper**	**ESP…**	**Pwr. Plus**	**Power Plus DSP**	**Chop.**	**ESP…**	**Pwr. Plus**	**Power Plus DSP**	**Chop.**
40001	10	Power Up with HV Mode				0-1				Off, Previous			
40002	10	IE Mode OFF/ON			Spare	0-1		N/a		Off, On			N/a
40003	10	Manual Mode OFF/ON			Spare	0-1		N/a		Off, On			N/a
40004	10	Fast Recovery OFF/ON		AutoTune Mode OFF/ON	Spare	0-1		N/a		Off, On			N/a
40005	10	Back Corona OFF/ON		Spare		0-1		N/a		Off, On		N/a	
40006	10	Setback Offset Mode		Auto-Select Mode	Spare	0-1		N/a		Manual, Auto		Off, On	N/a
40007	10	Max. Cond. Select	Spare			1, 10	N/a			Volt Curr	N/a		
40008	10	Spark Setback			Spare	1-30			N/a	%			N/a
40009	10	Quench time	Quench time (7)		Spare	1-10	0-20	1-20	N/a	Cycles	ms		N/a
40010	10	Fast Ramp	Fast Ramp (7)	Spare		2-20	0-20	N/a		Cycles	ms	N/a	
40011	10	Spark Rate			Spare	1-120			N/a	SPM			N/a

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Power Plus	Power Plus DSP	Chopper	ESP…	Pwr. Plus	Power Plus DSP	Chop.	ESP…	Pwr. Plus	Power Plus DSP	Chop.
40012	10	Ramp Mode		Spare		0-2		N/a		Linear, 3-Slope, 4-Slope		N/a	
40013	10	Current Limit				See Note 10	10 – 110			%			
40014	10	Secondary Voltage Limit				See Note 10	10 – 110			%			
40015	10	Secondary Undervoltage Trip			Spare	0-30			N/a	KVDC			N/a
40016	10	Undervoltage Delay			Spare	See Note 10	5 – 45		N/a	Sec			N/a
40017	10	Pri. Volt. Limit	Spare			See Note 10	N/a			%	N/a		
40018	10	Pri. Uv. Trip	Spare			0-200	N/a			VAC	N/a		
40019	10	IE Half-Cyc On	Spare			1-20	N/a			½ cyc	N/a		
40020	10	IE Cyc Off	Spare			1-20	N/a			Cyc	N/a		
40021	10	Back Corona Time		Spare		10-180		N/a		Sec		N/a	
40022	10	Back Corona Increment		Spare		5-20		N/a		%		N/a	
40023	10	Back Corona Delay		Spare		1-60		N/a		Sec		N/a	
40024	10	Back Corona Phaseback		Spare		0-20		N/a		%		N/a	
40025	10	Setback Offset Setting			Spare	10-100			N/a	%			N/a
40026	10	Max.Volt. Conduction	Max Duty Cycle(8)		Max. voltage limit(8)	90-160	50-100		50-102	Deg	%		
40027	10	Max Current Limit				30 - 110				%			
40028	10	Spare				N/a				N/a			
40029	10	Spare				N/a				N/a			
40030	10	Spare				N/a				N/a			
40031 - 40040	10	Aux Alarm 1 Name				0 - 9, A - Z, Space				ASCII			

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Power Plus	Power Plus DSP	Chopper	ESP…	Pwr. Plus	Power Plus DSP	Chop.	ESP…	Pwr. Plus	Power Plus DSP	Chop.
40041 - 40050	10	Aux Alarm 2 Name				0 - 9, A - Z, Space				ASCII			
40051 - 40060	10	Aux Alarm 3 Name				0 - 9, A - Z, Space				ASCII			
40061 - 40070	10	Aux Alarm 4 Name				0 - 9, A - Z, Space				ASCII			
40071	10	Ovr. Volt. Alarm. count	Ovr. Volt. Alarm. count			0-9999					See Note 9		
40072	10	Ovr. Current Alarm Count	Line Overcurrent count			0-9999							
40073	10	Sparks Over 60 Alarm Count	Spare	Line VAC abnormal count	Spare	0-9999	N/a	0-9999	N/a				
40074	10	Controller High Temp. Alarm Count	Spare	Vbus abnormal count	Spare	0-9999	N/a	0-9999	N/a				
40075	10	SCR Unbal. Count	Spare		Fuse count	0-9999	N/a		0-9999				
40076	10	On/Off Starts Count				0 - 9999							
40077	10	Undervoltage Alarm Count				0 - 9999							
40078	10	SCR High Temp Alarm Count	Spare			0-9999	N/a						
40079	10	Clear Aux Alarm 1 Count				0							
40080	10	Clear Aux Alarm 2 Count				0							
40081	10	Clear Aux Alarm 3 Count				0							
40082	10	Clear Aux Alarm 4 Count				0							
40083 - 40085	10	Hammer 1 Name			Spare	0-9, A-Z, space			N/a	ASCII			N/a
40086	10	Hammer 1 Initial Wait Hours			Spare	0-23			N/a	Hours			N/a
40087	10	Hammer 1 Initial Wait Mins			Spare	0-59			N/a	Minutes			N/a
40088	10	Hammer 1 Initial Wait Secs			Spare	0-59			N/a	Seconds			N/a

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Power Plus	Power Plus DSP	Chopper	ESP…	Pwr. Plus	Power Plus DSP	Chop.	ESP…	Pwr. Plus	Power Plus DSP	Chop.
40089	10	Hammer 1 Wait Hours			Spare	0-23			N/a	Hours			N/a
40090	10	Hammer 1 Wait Mins			Spare	0-59			N/a	Minutes			N/a
40091	10	Hammer 1 Wait Secs			Spare	0-59			N/a	Seconds			N/a
40092	10	Hammer 1 Duration Mins			Spare	0-59			N/a	Minutes			N/a
40093	10	Hammer 1 Duration Secs			Spare	0-59			N/a	Seconds			N/a
40094	10	Hammer 1 Clean Hours			Spare	0-23			N/a	Hours			N/a
40095	10	Hammer 1 Clean Mins			Spare	0-59			N/a	Minutes			N/a
40096	10	Hammer 1 Clean Secs			Spare	0-59			N/a	Seconds			N/a
40097	10	Hammer 1 Feedback			Spare	0-2			N/a	None, Input Closed, Input Open			N/a
40098	10	Hammer 1 Mode			Spare	0-3			N/a	See Note 3			N/a
40099 -101	10	Hammer 2 Name			Spare	0-9, A-Z, space			N/a	ASCII			N/a
40102	10	Hammer 2 Initial Wait Hours			Spare	0-23			N/a	Hours			N/a
40103	10	Hammer 2 Initial Wait Mins			Spare	0-59			N/a	Minutes			N/a
40104	10	Hammer 2 Initial Wait Secs			Spare	0-59			N/a	Seconds			N/a
40105	10	Hammer 2 Wait Hours			Spare	0-23			N/a	Hours			N/a
40106	10	Hammer 2 Wait Mins			Spare	0-59			N/a	Minutes			N/a
40107	10	Hammer 2 Wait Secs			Spare	0-59			N/a	Seconds			N/a
40108	10	Hammer 2 Duration Mins			Spare	0-59			N/a	Minutes			N/a
40109	10	Hammer 2 Duration Secs			Spare	0-59			N/a	Seconds			N/a
40110	10	Hammer 2 Clean Hours			Spare	0-23			N/a	Hours			N/a
40111	10	Hammer 2 Clean Mins			Spare	0-59			N/a	Minutes			N/a
40112	10	Hammer 2 Clean Secs			Spare	0-59			N/a	Seconds			N/a
40113	10	Hammer 2 Feedback			Spare	0-2			N/a	None, Input Closed, Input Open			N/a
40114	10	Hammer 2 Mode			Spare	0-3			N/a	See Note 3			N/a
40115 -117	10	Hammer 3 Name			Spare	0-9, A-Z, space			N/a	ASCII			N/a
40118	10	Hammer 3 Initial Wait Hours			Spare	0-23			N/a	Hours			N/a
40119	10	Hammer 3 Initial Wait Mins			Spare	0-59			N/a	Minutes			N/a
40120	10	Hammer 3 Initial Wait Secs			Spare	0-59			N/a	Seconds			N/a
40121	10	Hammer 3 Wait Hours			Spare	0-23			N/a	Hours			N/a
40122	10	Hammer 3 Wait Mins			Spare	0-59			N/a	Minutes			N/a
40123	10	Hammer 3 Wait Secs			Spare	0-59			N/a	Seconds			N/a
40124	10	Hammer 3 Duration Mins			Spare	0-59			N/a	Minutes			N/a
40125	10	Hammer 3 Duration Secs			Spare	0-59			N/a	Seconds			N/a
40126	10	Hammer 3 Clean Hours			Spare	0-23			N/a	Hours			N/a

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Power Plus	Power Plus DSP	Chopper	ESP…	Pwr. Plus	Power Plus DSP	Chop.	ESP…	Pwr. Plus	Power Plus DSP	Chop.
40127	10	Hammer 3 Clean Mins			Spare	0-59			N/a	Minutes			N/a
40128	10	Hammer 3 Clean Secs			Spare	0-59			N/a	Seconds			N/a
40129	10	Hammer 3 Feedback			Spare	0-2			N/a	None, Input Closed, Input Open			N/a
40130	10	Hammer 3 Mode			Spare	0-3			N/a	See Note 3			N/a
40131 -133	10	Hammer 4 Name			Spare	0-9, A-Z, space			N/a	ASCII			N/a
40134	10	Hammer 4 Initial Wait Hours			Spare	0-23			N/a	Hours			N/a
40135	10	Hammer 4 Initial Wait Mins			Spare	0-59			N/a	Minutes			N/a
40136	10	Hammer 4 Initial Wait Secs			Spare	0-59			N/a	Seconds			N/a
40137	10	Hammer 4 Wait Hours			Spare	0-23			N/a	Hours			N/a
40138	10	Hammer 4 Wait Mins			Spare	0-59			N/a	Minutes			N/a
40139	10	Hammer 4 Wait Secs			Spare	0-59			N/a	Seconds			N/a
40140	10	Hammer 4 Duration Mins			Spare	0-59			N/a	Minutes			N/a
40141	10	Hammer 4 Duration Secs			Spare	0-59			N/a	Seconds			N/a
40142	10	Hammer 4 Clean Hours			Spare	0-23			N/a	Hours			N/a
40143	10	Hammer 4 Clean Mins			Spare	0-59			N/a	Minutes			N/a
40144	10	Hammer 4 Clean Secs			Spare	0-59			N/a	Seconds			N/a
40145	10	Hammer 4 Feedback			Spare	0-2			N/a	None, Input Closed, Input Open			N/a
40146	10	Hammer 4 Mode			Spare	0-3			N/a	See Note 3			N/a
40147	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40148	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40149	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40150	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40151	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40152	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40153	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40154	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40155	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40156	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40157	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40158	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40159	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40160	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40161	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40162	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Power Plus	Power Plus DSP	Chopper	ESP…	Pwr. Plus	Power Plus DSP	Chop.	ESP…	Pwr. Plus	Power Plus DSP	Chop.
40163	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40164	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40165	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40166	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40167	10	Spare	Spare		Spare	N/a			N/a	N/a			N/a
40168	**10**	**Turn On/Off High Voltage**				**0-1 (Write-Only)**				**Off, On See Note 11**			
40169	**10**	**Clear Alarm**				**0-13**		**0-24**	**0-12**	**See Note 6**			
40170	10	Power Control Active			Spare	0-1			N/a	No, Yes			N/a
40171	10	Spare	IE ms On		Inverter Freq.	N/a	1-100		10-30	N/a	mSec * 10		KHz x 10
40172	10	Spare	IE ms Off		Spare	N/a	1-200		N/a	N/a	mSec * 10		N/a
40173	10	Spare			Fuse Mode	N/a			0-1	N/a			Off, On
40174	10	Spare			Fuse Time	N/a			1-30	N/a			sec
40175	10	Spare			Fuse Setback	N/a			1-99	N/a			%
40176	10	Spare			Output Type	N/a			0-1	N/a			AC, DC
40177	10	Spare				N/a				N/a			
:													
:													
40400	10	Spare				N/a				N/a			
40401	11	Power Up with HV Mode				0-1				Off, On			
:													
:													
49600	33	Spare				N/a				N/a			

The register definitions for each of the remaining Controller's is in the identical order as Controller Address 10 registers offset by 400. Controller Address 11 registers start at 30401, Controller Address 12 registers start at 30801, etc.

Note 1: The following table defines the alarm value association:

Value	Alarm Description			
	ESP Power Optimizer	PowerPlus	PowerPlus DSP	Chopper
0	No Alarms			
1	Controller Ovr.	Line Overcurrent		

Value	Alarm Description			
	ESP Power Optimizer	PowerPlus	PowerPlus DSP	Chopper
	current			
2	SCR Over Temp	Secondary Overcurrent		
3	Controller High Oil Temp	Overvoltage (hardwr)		Spare
4	Controller Low Oil Level	Open Circuit		IGBT Error
5	Undervoltage			
6	Ovr. Volt	Overvoltage (softwr)		
7	SCR Unbal.	Over Temp		Bus Ovr. current
8	Loss of Line Sync	Spare		Fuse Alarm
9	Aux Alarm 1			
10	Aux Alarm 2			
11	Aux Alarm 3			
12	Aux Alarm 4			
13	Hammer 1 Alarm			Spare
14	Hammer 2 Alarm			Spare
15	Hammer 3 Alarm			Spare
16	Hammer 4 Alarm			Spare
17	Spare		Line VAC	Spare
18	Spare		Vbus Low	Spare
19	Spare		Liq Lev Low	Spare
20	Spare		Door Open	Spare
21	Spare		Fan Con	Spare
22	Spare		Step Con	Spare
23	Spare		Main Con	Spare
24	Spare			

Note 2: The following table defines the limit value association:

Value	Limit Description		
	ESP Power Optimizer	PowerPlus	Chopper
0	Controller in Ramp Mode		
1	Current Limit		
2	Voltage Limit		
3	Cond. Limit	Duty Cycle Limit	Full Duty Cycle
4	Back Corona Hold		Fuse Process Active

5	V/I Curve in Operation		
6	Spark Occured		
7	Arc Occurred	Spare	
8	Back Corona Check		Spare

Note 3: The following table defines the hammer mode value association:

Value	Hammer Mode Description		
	ESP Power Optimizer	PowerPlus	Chopper
0	Off		Spare
1	Program Run		Spare
2	Program Run with Clean		Spare
3	Continuous		spare

Note 6: The following table defines the clear alarm value association:

Value	Alarm Description			
	ESP Power Optimizer	PowerPlus	PowerPlus DSP	Chopper
0	No Alarms			
1	Controller Ovr. current	Line Overcurrent		
2	SCR Over Temp	Secondary Overcurrent		
3	Controller High Oil Temp	Overvoltage (hardwr)		
4	Controller Low Oil Level	Open Circuit		IGBT Error
5	Undervoltage			
6	Ovr. Volt	Overvoltage (softwr)		
7	SCR Unbal.	Over Temp		Bus Ovr. current
8	Loss of Line Sync	Spare		Fuse Alarm
9	Aux Alarm 1			
10	Aux Alarm 2			
11	Aux Alarm 3			
12	Aux Alarm 4			
13	Clear Next Hammer Alarm			Spare
14	Spare			
15	Spare			
16	Spare			

Value	Alarm Description			
	ESP Power Optimizer	PowerPlus	PowerPlus DSP	Chopper
17	Spare		Line VAC	Spare
18	Spare		Vbus Low	Spare
19	Spare		Liq Lev Low	Spare
20	Spare		Door Open	Spare
21	Spare		Fan Con	Spare
22	Spare		Step Con	Spare
23	Spare		Main Con	Spare
24	Spare			

Note 7:
"0" will disable function

Note 8:
A value equal to zero will disable this feature.

Note 9:
Sum of Hardware and Software detected Over-Voltage Alarms.

Note 10:
Pri. Voltage Limit range is 30 – 107% for GVC Controller software **v4.02 and below**;
Pri. Voltage Limit range is 10 – 110% for GVC Controller software **v4.03 and above**;
Sec. Voltage Limit range is 50-102% for GVC Controller software **v4.02 and below**;
Sec. Voltage Limit range is 10-110% for GVC Controller software **v4.03 and above**;
Sec. Current Limit range is 0 – 110% for GVC Controller software **v4.02 and below**;
Sec. Current Limit range is 10 – 110% for GVC Controller software **v4.03 and above**;
UV Trip delay range is 15-45 sec for GVC Controller software **v4.02 and below**;
UV Trip delay range is 5-45 sec for GVC Controller software **v4.03 and above**;
UV Trip delay range is 5-45 sec for Chopper Controller software .
UV Trip delay range is 5-45 sec for Power Plus Controller software.

Note 11:
Register 40168 – Write a '1' to this register only once to turn the HV on. Repeatedly writing a '1' to this register will act as restarts, preventing the HV from ramping up.

5.3.8 System Holding Register

The following registers are reserved for controlling the DCS*i*.

Register #	Description	Valid Range	Units
49601 See note 1	**DCSi Reset Command Clears all memory locations and reinitializes the UARTs.**	**1**	**N/A**
49602	Spare	0	
:			
:			
49999	Spare	0	

Note 1:
DCSI firmware Version 3.4 or higher: Writing a value = 1 via Function code 06 to register 49601 Clears all memory locations and reinitializes the UARTs. For older version reading register 49601 via function code 03 initiated the reset.

Appendix A : rs232 to Ethernet Modbus TCP converter:

If your DCS/PLC supports MODBUS over Ethernet (Modbus TCP), you can add a commercially available converter to the DCSi rs232 port to convert the native rs232 modbus data to the Modbus TCP protocol.

We have tested and verified that a product manufactured by Digi Corporation is compatible with the DCSi to perform this function. The Product tested was a Digi model "DIGI ONE TS" p/n 70001805. The Digi One TS was configured for use in it's 'Industrial Automation' mode. For further instructions please refer to the "Industrial Automation Configuration for use with Modbus" section of the Digi One TS user guide.

Appendix B: Fiber Optic rs485 Media Converter:

The DCSi supports the use of any commercially available media converters enabling the use of fiber optic cable on the rs485 comm link in place of shielded cable. However due to the multi-drop configuration of the rs485 comm link, the network must be converted back to shielded cable prior to the first Controller. Refer to the DCSi One Line Communication Diagram in this manual.

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