DCSi-III:

ESP Power Optimizer,

Power Plus Optimizer,

Power Plus DSP,

Chopper Optimizer

Users Guide

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Revisions

Rev.	Date	Author	Description
1.0	7/20/2007	R. Zara	Initial Draft
1.1	11/14/2007	R. Zara	Initial Release
1.2	8/11/08	R. Zara	'Note 2' added 'Arc Occurred' enumeration for PowerPlus DSP
1.3	9.2.08	R. Zara	Corrected Range for P+DSP reg 40004 ot 40006
1.4	11/11/2010	Jim Stevenson	Replaced the Chopper device type with the Optimizer-DSP and added a firmware update procedure
1.5	7/17/2012	P. Murashka	Changed number of NWL nodes from 12/24 to 16/32 (DCSi firmware 4.02)
1.6	3/22/2013	R. Zara	Clarified stop bits in section 5.1

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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.

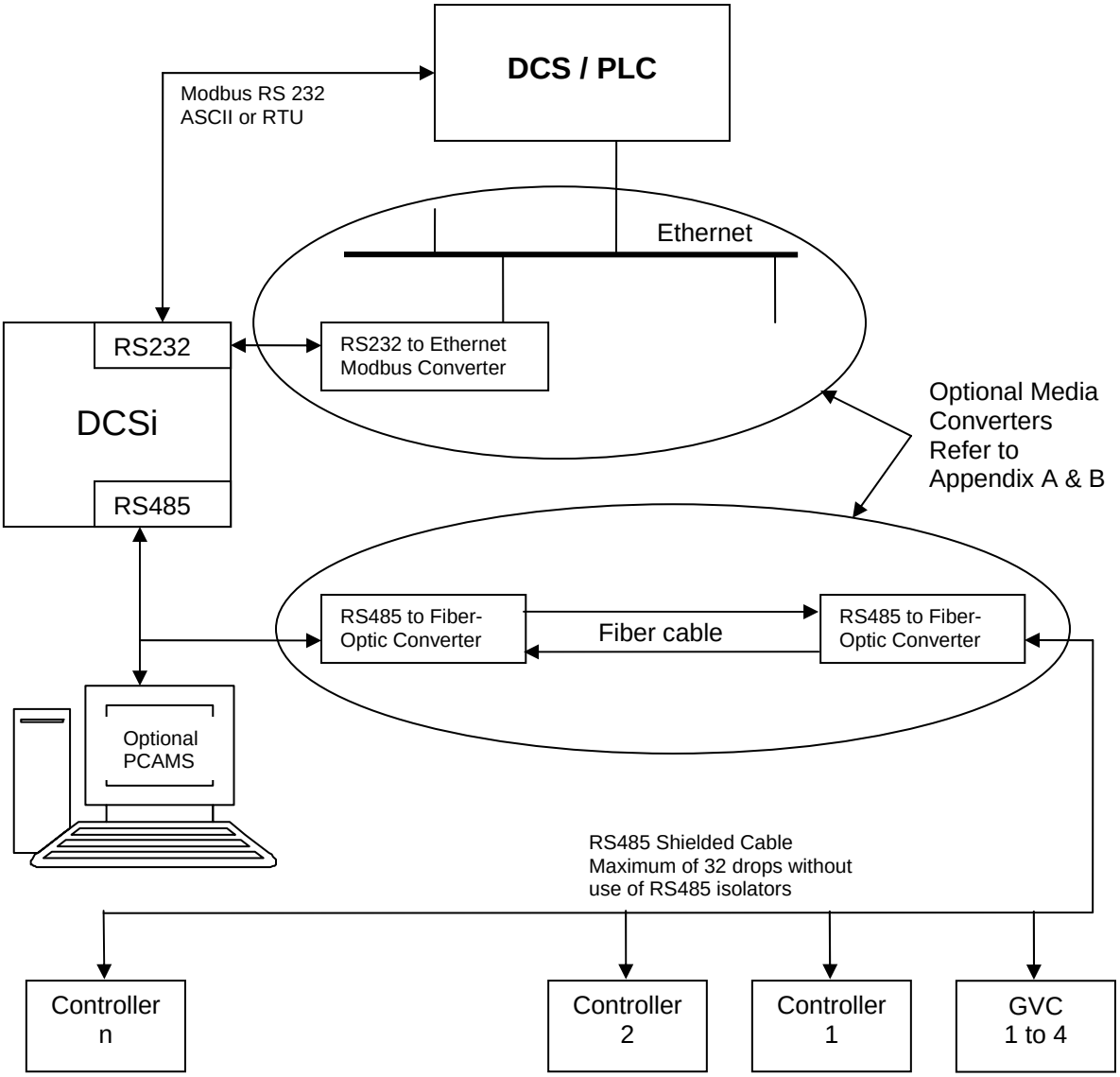
2. Acronyms/Definitions

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 DCSi Microcontroller Bd

NWL's Communications Microcontroller Board with the following features:

Processor	ST Micro UPSD3354, 40 MHz clock
Communication Ports	1 RS485 using microcontroller UART 1 RS232 using microcontroller UART
Memory	288K x 8 Flash 32K x 8 RAM
Watchdog Timer	

4.2 DCSi Power Supply/Terminal Module

NWL Transformers DCS*i* Power Supply/Terminal Module

Input	100-240 +10% -15% VAC, 50/60 Hz
Output	5 VDC ± 5% @ 1000 mA
Environment	0° - 70° C operating, 5% - 95% relative humidity, non-condensing
Switches	10 position DIP switch for configuration, rear power switch
LED's	LED's showing Power and link activity.

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*	Rs232 3-pin Terminal	DCS*i, 9pin D-sub*
Pin 1	Carrier Detect (DCD)			
Pin 2	Receive Data (RXD)	————	Pin 2	Pin 3
Pin 3	Transmit Data (TXD)	————	Pin 1	Pin 2
Pin 4	Data Terminal Ready (DTR)			
Pin 5	Ground (GND)	————	Pin 3	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

For convenience also located on the front panel of the DCSi is a network port (RJ45) which can be used to attach a GVC Display module for viewing and/or confirmation of Optimizer network data. Power for the GVC is provided via this port therefore no remote power supply is required.

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, no parity and 1 stop bit Modbus ASCII: 1 start bit, 8 data bits, no parity and 1 stop bit Modbus Slave Addresses configurable Note: To obtain Modbus ASCII 7-N-1 communication parameters a baud rate converter must be used.

5.2 Dip Switch Configuration

The DCS*i's* configuration is controlled via a 10 position Dip switch located on the front of the unit. The following tables provide the details for each switch position.

SW1-1	DCS Link Baud Rate
Off	38400
On	19200 (default)

SW1-2	DCSi Mode
Off	Redundant
On	Primary (default)

SW1-3	# of NWL Nodes *
Off	16 (default)
On	32

* - For best performance SWI-3 should be set to scan the minimum number of nodes connected. Therefore, if the attached RS485 communication line has 16 or fewer Optimizer nodes, setting this switch to off will provide better performance. For DCSi firmware versions 4.01 and older, the number of supported nodes is 12 (default)/24.

SW1-4	*Unused*

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

SW1-7 Bit 6	Protocol

Off	Modbus ASCII
On	Modbus RTU (default)

SW1-8	Extended Registers **
Off	No
On	Yes (default)

** - 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.

SW1-9	*Unused*

SW1-10	Rs485 120 ohm terminating resistor
Off	None
On	In Circuit (default)

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 (based on SW1-5,6)	Controller Address Range
1, 5, 9, 13	10 - 33
2, 6, 10, 14	34 - 41

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:

	Optimizer Address	
Register # Range	1st Modbus Slave	2nd Modbus Slave
30001 – 30400	10	34
30401 – 30800	11	35
30801 – 31200	12	36
31201 – 31600	13	37
31601 – 32000	14	38
32001 – 32400	15	39
32401 – 32800	16	40
32801 – 33200	17	41
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	Optimizer DSP	Power Plus	Power Plus DSP	ESP…	Opt. DSP	PowerPlus	PowerPlus DSP	ESP…	Optimizer DSP	PowerPlus	PowerPlus DSP
30001	10	Communication Status				0 – 1				Disabled/Enabled			
30002	10	Primary Voltage		Line voltage		0 – 720				VAC			
30003	10	Primary Current		Line current		0-750				AAC			
30004	10	Sec. Voltage1		KV		0 – 200				KVDC			
30005	10	Sec. Voltage2		KVpk		0-200				KVDC			
30006	10	Secondary Current				0 – 5000				mADC			
30007	10	Secondary Power				0 – 9999				KW x 10			
30008	10	Conduction Angle		Duty Cycle		0-160		0-10000		degrees		% x100	
30009	10	Current cond.		KVproduct		0-180		0-40000		degrees		KV	
30010	10	Spark rate				0-999				Sparks/min			
30011	10	Arc Rate				0-99				Arcs/min			
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 Coil Status				0-1				Off,On			
30016	10	Hammer 2 Coil Status				0-1				Off,On			
30017	10	Hammer 3 Coil Status				0-1				Off,On			
30018	10	Hammer 4 Coil Status				0-1				Off,On			
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	Primary Current x10		Line Current x10		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	Optimizer DSP	Power Plus	Power Plus DSP	ESP…	Opt. DSP	PowerPlus	PowerPlus DSP	ESP…	Optimizer DSP	PowerPlus	PowerPlus DSP
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	KV1 peak	Spare	Bus Voltage	N/a	0-200	N/a	0-700	N/a	KVDC	N/a	VDC
30036	10	Spare	KV1 product	Spare	Bus Current	N/a	0-9999	N/a	0-500	N/a	KVDC	N/a	ADC
30037	10	Spare	KV2 peak	Spare	Fan Current	N/a	0-200	N/a	0-100	N/a	KVDC	N/a	AAC x10
30038	10	Spare	KV2 product	Spare	Heat Sink Temp.	N/a	0-9999	N/a	0-99	N/a	KVDC	N/a	Deg C
30039	10	Spare			IE ON Actual	N/a			1-200	N/a			mSec x10
30040	10	Spare			IE OFF Actual	N/a			1-990	N/a			mSec x10
:													
:													
30399	10	Device Type				1,2	5,6	3,4	9,10	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	Spare		
:				
:				
39994	N/a	NWL Link Communication Status	0-1	Disabled, Enabled
39995	N/a	DIP Switch Configuration	0-255	
39996	N/a	DCSi Uptime Days counter	0-65535	Days
39997	N/a	DCSi Uptime Hours counter	0-24	Hours
39998	N/a	DCSi Uptime Seconds counter	0-3600	Seconds
39999		DCSi Firmware Version ID	0-999	Version x 100
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		Register # Range	Optimizer Address
40001 – 40400	10		45201 – 45600	23
40401 – 40800	11		45601 – 46000	24
40801 – 41200	12		46001 – 46400	25
41201 – 41600	13		46401 – 46800	26
41601 – 42000	14		46801 – 47200	27
42001 – 42400	15		47201 – 47600	28
42401 – 42800	16		47601 – 48000	29
42801 – 43200	17		48001 – 48400	30
43201 – 43600	18		48401 – 48800	31
43601 – 44000	19		48801 – 49200	32
44001 – 44400	20		49201 – 49600	33
44401 – 44800	21		49601 – 50000	DCSi Status
44801 – 45200	22			

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	**Opt DSP**	**Power Plus**	**Power Plus DSP**	**ESP …**	**Opt DSP**	**PowerPlus**	**PowerPlus DSP**	**ESP…**	**Optimizer DSP**	**PowerPlus**	**Power Plus DSP**
40001	10	Power Up with HV Mode				0-1				Off, Previous			
40002	10	IE Mode OFF/ON				0-1				Off, On			
40003	10	Manual Mode OFF/ON				0-1				Off, On			
40004	10	Fast Recovery OFF/ON			AutoTune Mode OFF/ON	0-1			0-1	Off, On			Off,On
40005	10	Back Corona OFF/ON			Spare	0-1			N/a	Off, On			N/a
40006	10	Setback Offset Mode			Auto-Select Mode	0-1			0-1	Manual, Auto			Off,On
40007	10	Max. Cond. Select		Spare		1, 10		N/a		Volt Curr		N/a	
40008	10	Spark Setback				1-30				%			
40009	10	Quench time		Quench time (7)		1-10		0-20	1-20	Cycles		ms	ms
40010	10	Fast Ramp		Fast Ramp (7)	Spare	2-20		0-20	N/a	Cycles		ms	N/a
40011	10	Spark Rate				1-120				SPM			
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				0-30				KVDC			
40016	10	Undervoltage Delay				See Note 10		5 – 45		Seconds			

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Opt DSP	Power Plus	Power Plus DSP	ESP …	Opt DSP	PowerPlus	PowerPlus DSP	ESP…	Optimizer DSP	PowerPlus	Power Plus DSP
40017	10	Pri. Volt. Limit		Spare		See Note 10	10-110	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				10-100				%			
40026	10	Max.Volt. Conduction		Max Duty Cycle(8)		90-160		50-100		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			
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	0-9999		N/a	0-9999				
40074	10	Controller High Temp. Alarm Count		Spare	Vbus abnormal count	0-9999		Spare	0-9999				

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Opt DSP	Power Plus	Power Plus DSP	ESP …	Opt DSP	PowerPlus	PowerPlus DSP	ESP…	Optimizer DSP	PowerPlus	Power Plus DSP
40075	10	SCR Unbal. Count		Spare		0-9999		N/a					
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				0-9, A-Z, space				ASCII			
40086	10	Hammer 1 Initial Wait Hours				0-23				Hours			
40087	10	Hammer 1 Initial Wait Mins				0-59				Minutes			
40088	10	Hammer 1 Initial Wait Secs				0-59				Seconds			
40089	10	Hammer 1 Wait Hours				0-23				Hours			
40090	10	Hammer 1 Wait Mins				0-59				Minutes			
40091	10	Hammer 1 Wait Secs				0-59				Seconds			
40092	10	Hammer 1 Duration Mins				0-59				Minutes			
40093	10	Hammer 1 Duration Secs				0-59				Seconds			
40094	10	Hammer 1 Clean Hours				0-23				Hours			
40095	10	Hammer 1 Clean Mins				0-59				Minutes			
40096	10	Hammer 1 Clean Secs				0-59				Seconds			
40097	10	Hammer 1 Feedback				0-2				None, Input Closed, Input Open			
40098	10	Hammer 1 Mode				0-3				See Note 3			
40099 -101	10	Hammer 2 Name				0-9, A-Z, space				ASCII			
40102	10	Hammer 2 Initial Wait Hours				0-23				Hours			
40103	10	Hammer 2 Initial Wait Mins				0-59				Minutes			
40104	10	Hammer 2 Initial Wait Secs				0-59				Seconds			
40105	10	Hammer 2 Wait Hours				0-23				Hours			
40106	10	Hammer 2 Wait Mins				0-59				Minutes			
40107	10	Hammer 2 Wait Secs				0-59				Seconds			
40108	10	Hammer 2 Duration Mins				0-59				Minutes			
40109	10	Hammer 2 Duration Secs				0-59				Seconds			
40110	10	Hammer 2 Clean Hours				0-23				Hours			

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Opt DSP	Power Plus	Power Plus DSP	ESP …	Opt DSP	PowerPlus	PowerPlus DSP	ESP…	Optimizer DSP	PowerPlus	Power Plus DSP
40111	10	Hammer 2 Clean Mins				0-59				Minutes			
40112	10	Hammer 2 Clean Secs				0-59				Seconds			
40113	10	Hammer 2 Feedback				0-2				None, Input Closed, Input Open			
40114	10	Hammer 2 Mode				0-3				See Note 3			
40115 -117	10	Hammer 3 Name				0-9, A-Z, space				ASCII			
40118	10	Hammer 3 Initial Wait Hours				0-23				Hours			
40119	10	Hammer 3 Initial Wait Mins				0-59				Minutes			
40120	10	Hammer 3 Initial Wait Secs				0-59				Seconds			
40121	10	Hammer 3 Wait Hours				0-23				Hours			
40122	10	Hammer 3 Wait Mins				0-59				Minutes			
40123	10	Hammer 3 Wait Secs				0-59				Seconds			
40124	10	Hammer 3 Duration Mins				0-59				Minutes			
40125	10	Hammer 3 Duration Secs				0-59				Seconds			
40126	10	Hammer 3 Clean Hours				0-23				Hours			
40127	10	Hammer 3 Clean Mins				0-59				Minutes			
40128	10	Hammer 3 Clean Secs				0-59				Seconds			
40129	10	Hammer 3 Feedback				0-2				None, Input Closed, Input Open			
40130	10	Hammer 3 Mode				0-3				See Note 3			
40131 -133	10	Hammer 4 Name				0-9, A-Z, space				ASCII			
40134	10	Hammer 4 Initial Wait Hours				0-23				Hours			
40135	10	Hammer 4 Initial Wait Mins				0-59				Minutes			
40136	10	Hammer 4 Initial Wait Secs				0-59				Seconds			
40137	10	Hammer 4 Wait Hours				0-23				Hours			
40138	10	Hammer 4 Wait Mins				0-59				Minutes			
40139	10	Hammer 4 Wait Secs				0-59				Seconds			
40140	10	Hammer 4 Duration Mins				0-59				Minutes			
40141	10	Hammer 4 Duration Secs				0-59				Seconds			
40142	10	Hammer 4 Clean Hours				0-23				Hours			
40143	10	Hammer 4 Clean Mins				0-59				Minutes			
40144	10	Hammer 4 Clean Secs				0-59				Seconds			
40145	10	Hammer 4 Feedback				0-2				None, Input Closed, Input Open			
40146	10	Hammer 4 Mode				0-3				See Note 3			
40147	10	Spare				N/a				N/a			
40148	10	Spare				N/a				N/a			

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Opt DSP	Power Plus	Power Plus DSP	ESP …	Opt DSP	PowerPlus	PowerPlus DSP	ESP…	Optimizer DSP	PowerPlus	Power Plus DSP
40149	10	Spare				N/a				N/a			
40150	10	Spare				N/a				N/a			
40151	10	Spare				N/a				N/a			
40152	10	Spare				N/a				N/a			
40153	10	Spare				N/a				N/a			
40154	10	Spare				N/a				N/a			
40155	10	Spare				N/a				N/a			
40156	10	Spare				N/a				N/a			
40157	10	Spare				N/a				N/a			
40158	10	Spare				N/a				N/a			
40159	10	Spare				N/a				N/a			
40160	10	Spare				N/a				N/a			
40161	10	Spare				N/a				N/a			
40162	10	Spare				N/a				N/a			
40163	10	Spare				N/a				N/a			
40164	10	Spare				N/a				N/a			
40165	10	Spare				N/a				N/a			
40166	10	Spare				N/a				N/a			
40167	10	Spare				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**	**0-19**	**0-13**	**0-23**	**See Note 6**			
40170	10	Power Control Active				0-1				No, Yes			
40171	10	Spare		IE ms On		N/a		1-100		N/a		mSec * 10	
40172	10	Spare		IE ms Off		N/a		1-200		N/a		mSec * 10	
40173	10	Spare				N/a				N/a			
40174	10	Spare				N/a				N/a			
40175	10	Spare				N/a				N/a			
40176	10	Spare				N/a				N/a			
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			
:													
:													

Reg#	Addr	Description				Range				Units			
		ESP Power Optimizer	Opt DSP	Power Plus	Power Plus DSP	ESP …	Opt DSP	PowerPlus	PowerPlus DSP	ESP…	Optimizer DSP	PowerPlus	Power Plus DSP
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	Optimizer DSP	PowerPlus	PowerPlus DSP
0	No Alarms			
1	Over-Current		Line Over-Current	
2	SCR Over Temp		Secondary Overcurrent	
3	High Oil Temp		Over-Voltage (hardware)	
4	Low Oil Level		Open Circuit	
5	Undervoltage			
6	Over-Voltage (software)			
7	SCR Unbalance		Over Temp	
8	Loss of Line Sync		Spare	
9	Aux Alarm 1			
10	Aux Alarm 2			
11	Aux Alarm 3			
12	Aux Alarm 4			
13	Hammer 1 Alarm			
14	Hammer 2 Alarm			
15	Hammer 3 Alarm			
16	Hammer 4 Alarm			
17	Spare	Voltage Reference	Spare	Line VAC
18	Spare	Low Battery	Spare	VBus Low
19	Spare	Blown Fuse	Spare	Oil Level Low
20	Spare			Door Open
21	Spare			Fan Contactor
22	Spare			Step Contactor
23	Spare			Main Contactor
24	Spare			

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

Value	Limit Description			
	ESP Power Optimizer	Optimizer DSP	PowerPlus	PowerPlus DSP
0	Controller in Ramp Mode			
1	Current Limit			
2	Voltage Limit			
3	Conduction Angle Limit		Duty Cycle Limit	
4	Back Corona Hold			
5	V/I Curve in Operation			
6	Spark Occurred			
7	Arc Occurred			
8	Back Corona Check			

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

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

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

Value	Alarm Description			
	ESP Power Optimizer	Optimizer DSP	PowerPlus	PowerPlus DSP
0	No Alarms			
1	Over-Current		Line Over-Current	
2	SCR Over Temp		Secondary Over-Current	
3	High Oil Temp		Over-Voltage (hardware)	
4	Low Oil Level		Open Circuit	
5	Under-Voltage			
6	Over-Voltage (software)			
7	SCR Unbal.		Over Temp	
8	Loss of Line Sync		Spare	
9	Aux Alarm 1			
10	Aux Alarm 2			
11	Aux Alarm 3			

Value	Alarm Description			
	ESP Power Optimizer	**Optimizer DSP**	**PowerPlus**	**PowerPlus DSP**
12	Aux Alarm 4			
13	Clear Next Hammer Alarm			
14	Spare			
15	Spare			
16	Spare			
17	Spare	Voltage Ref	Spare	Line VAC
18	Spare	Low Battery	Spare	V-Bus Low
19	Spare	Blown Fuse	Spare	Oil Level Low
20	Spare			Door Open
21	Spare			Fan Contactor
22	Spare			Step Contactor
23	Spare			Main Contactor
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	Spare	-	N/A
:			
49998	DCSi ENTER DIAG MODE Command Reserved for NWL use	0-1	N/A
49999 **See note 1**	**DCSi Reset Command** **Clears all memory locations and reinitializes the UARTs.**	**1**	**N/A**

Note 1:
Writing a value = 1 via Function code 06 to register 49999 Clears all memory locations and reinitializes the UARTs.

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.

Appendix C: Installing Firmware Updates

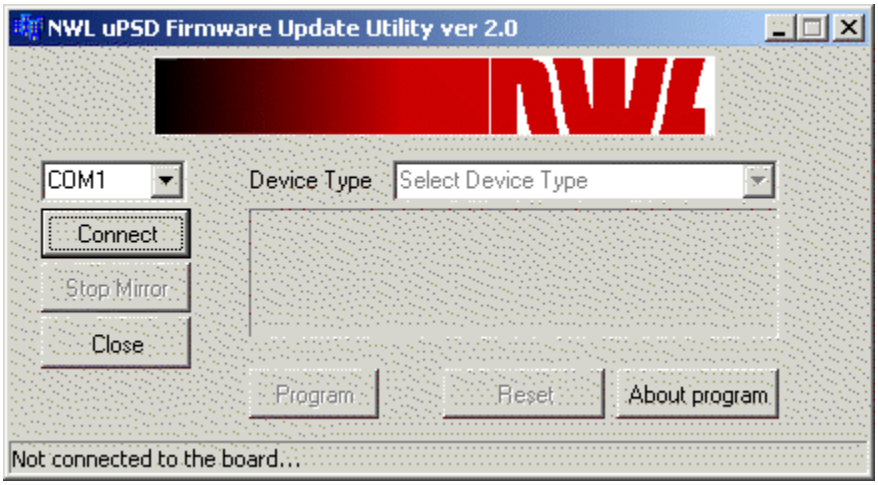
1) Obtain the firmware update files from NWL and copy them to a folder on your computer. (Note: Your computer must be running Microsoft Windows) The four files that are required are listed below.

   NWL_IAP.exe
   Dcsbanking0.hex
   Dcsbanking1.hex
   DcsbankingCommon.hex

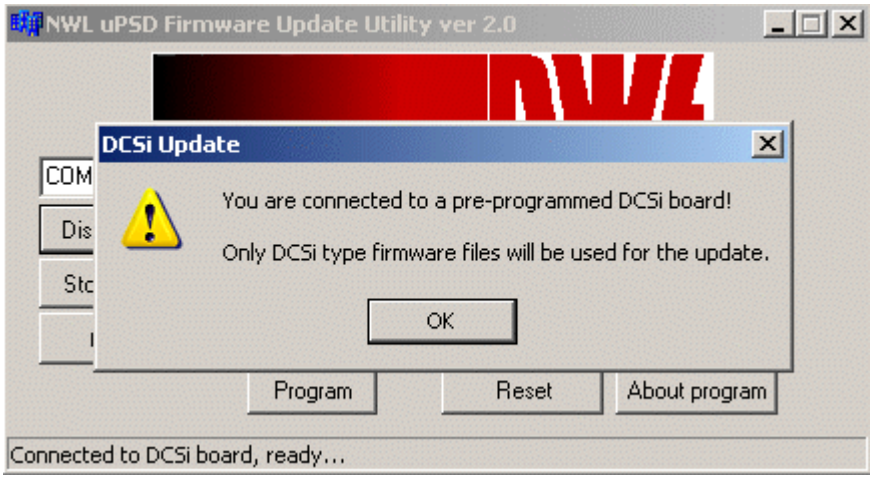
2) Connect the DCSi's 9-pin serial connector to your computer using a null modem cable. If your computer does not have a RS-232 port, use a USB-to-RS232 adapter.

3) With the DCSi off, press and hold the 'Program Flash' button while turning the power on. This will place the DCSi into a boot mode that will allow its firmware to be updated. The speaker will beep once every 10 seconds to verify the DCSi is in this programming mode.

4) Start the software by double-clicking on the NWL_IAP.exe file. The initial screen for this software is shown below.



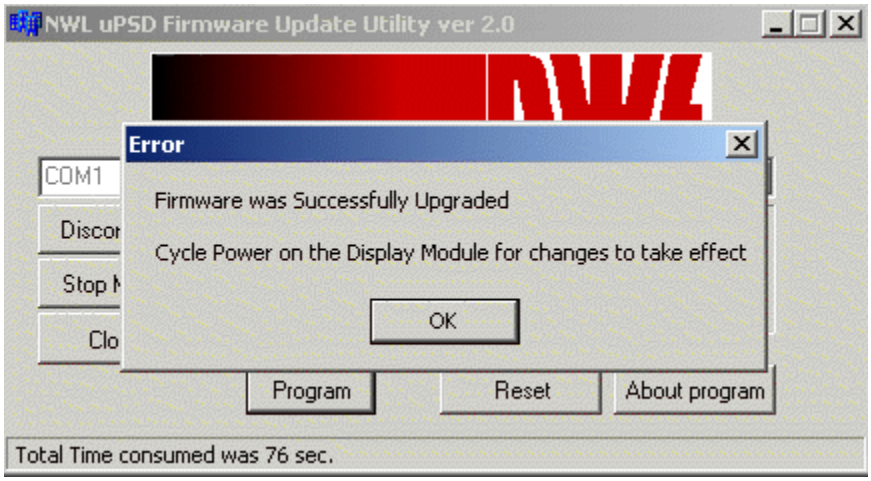
5) Using the list-box, select the appropriate COM port for your computer and click the 'Connect' button. The screen you will see next is shown below.



6) Click ‘OK’ to close the ‘DCSi Update’ window. You will now see the screen shown below.

7) You are now ready to update the firmware. During the update process, DO NOT remove power from the DCSi or from the computer. Start the update by clicking the ‘Program’ button. The update process typically takes less than 2 minutes to complete. At the end of the update, a message will be displayed indicating the status of the update, either successful or failed.

8) If the update is successful, you will see the screen shown below. Click ‘OK’ to close this message. Close the Firmware Update Utility. Power-cycle the DCSi. It is now ready for normal operation. You can verify the firmware revision number by reading input register # 39999.



9) If the update failed, you should verify that your cable connections are good and verify that you have all of the required files. Once this is verified, retry the process from the beginning. If the update fails a second time, call NWL for assitance at 1-800-PICK-NWL.

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