NWL Power Systems

PRODUCT MANUAL

FOR S^4
(SOLID STATE STEP START)
CONTROLLER

Model Number 113080
121504

SERVICE
Skilled factory service personnel are available for your needs simply by calling NWL at 609-298-7300 any business day from 8 AM to 5 PM, Eastern time.

EMERGENCY ACTION
At time of delivery, the product should be carefully inspected. Any damage, leakage, etc. should be noted on the shipping memorandum. A damage claim should be filed with the transportation company immediately.
NWL should be notified by calling (609)298-7300.

Repair and servicing of the equipment should be performed by a qualified NWL representative.

After delivery but prior to installation, if any damage is noted, please call NWL immediately.

On or after installation, if unit malfunctions, remove all power and call NWL immediately.

WARNING! High Voltage!

NWL power supplies and control equipment contain dangerous and potentially lethal voltages.

- Do not attempt to service the device while it is powered up or operating.
- Turn off power to unit and carefully follow the grounding procedures described within the broadcast manual before doing any physical or electrical work on the broadcast unit.
- Take precautions against shock or electrocution
- Do not stand in water or on damp surfaces while working on the controller or load.
- NWL will not be liable for death, injury or damages resulting from the unsafe installation or operation of this device.
- DANGER! - To reduce the risk of Electrical Shock, Carefully follow the instructions within this manual.

These are Important Safety Instructions

SAVE THESE INSTRUCTIONS!

NWL – PERFORMANCE AND RELIABILITY

NWL specializes in the design and manufacturing of power supplies, transformers, controllers, capacitors and allied devices for a variety of end uses. It's the kind of company you didn't think existed anymore: customer-responsive, market-driven and experienced in all areas of power technology. We also maintain a degree of control over our products which is unusual in today's "built elsewhere, assembled here" environment. We develop, design, manufacture, distribute and support all our products from start to finish. As a result, you can be sure that all components are compatible...that design integrity has been preserved ...and that one high standard of quality prevails throughout — ours.

It also means that, if you need support of our product or require adaptation to your specific needs, we will have the answers. And, with over sixty years of experience in creating components, controls and power supplies for a broad range of industries, you'll also get the benefit of proven techniques which we adapt from one market to another

That's all part of our commitment to providing a total solution that meets or exceeds the needs of the systems integrators, OEMs and end-users who look to us for innovation with solid reliability.

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INTRODUCTION TO THE S^4 (Solid State Step Start)

NWL's Solid State Step Start controller (S^4) is a compact electronic step start module that replaces the need for older costly mechanical step starters used on today's broadcast power supply equipment. Like other NWL products, the S^4 — down to the sheet metal cabinet and circuit boards — has been designed and made totally by NWL. This solid state device offers many advantages over traditional mechanical step starts. The S^4 utilizes SCRs for it's main on/off control of the input power. Therefore, it will interrupt fault current due to external crowbar operation in less than 8.3ms. This reduces input circuit breaker wearout. Most electro-mechanical contactors are not capable of shutting down this fast, and the few vacuum types that do are extremely costly to obtain and maintain.

The S^4 is rated to handle three phase broadcast units up to 100kva at a maximum of 120aac and 600vac at either 50 or 60Hz. The topology of the unit is very similar to traditional step start units whereas the incoming power is diverted through a series resistance through a switch (SCR switch in this case) into the broadcast load during the Step function and after a predetermined period of time, the Start function engaged by a second SCR switch bypasses the resistance to provide full power to the load. The Step/Start timing is set to an optimum factory predetermined setting where the Step function is on for 300msec.

Features within the S^4 include over-current protection, SCR and Resistor thermal protection, a shorted SCR detector and an open/non-firing SCR indicator. Provisions are also provided for interlocking a front end contactor to provide full system isolation.

The S^4 offers the user a rugged and tough device based upon use-proven technology which can be relied upon to provide years of service with minimum maintenance.

Important

One of the greatest benefits to the S^4 Controller is its ability to shutdown the front end power to a broadcast unit in 8.3ms or less. The S^4 controller's history of reliability is very strong. Many users are now using this fast shutdown benefit as a means of eliminating a costly crowbar system to provide a means of protection against internal arc faults within their tubes. Although there is great success with this new type of tube protection, NWL does not promote the elimination of other essential tube protection devices and will not be held liable for any damages incurred if this equipment fails to detect and respond to a tube arc.

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SHIPPING, RECEIVING, HANDLING AND STORAGE

Shipping and Receiving

NWL controllers are shipped on heavy-duty pallets and covered with plastic envelopes for protection, unless otherwise specified. The transportation means used will be suitable for equipment containing electronic gear.

As with all electronic equipment, handling is critical so that the internal parts are protected and the integrity is not compromised.

The equipment should be examined as soon as it is received. Be sure that:

- There is no apparent damage to the skid or surrounding packaging.
- The plastic envelope has remained intact.

Remember, any external damage may be an indication of internal damage.

At time of delivery, the product should be carefully inspected. Any damage should be noted on the shipping memorandum. A damage claim should be filed with the transportation company immediately.

NWL should be notified by calling (609)298-7300.

Handling:
The unit can be removed from the truck with a forklift. Two handles are provided on each side of the S^4 to facilitate two people in lifting the unit off of the pallet and into place. The unit weights 60Lbs and it is recommended that two people be used to lift the unit. If the unit is to be lifted using an overhead hoist or crane, straps can be attached to the two slotted mounting holes at the top of the unit. These holes are sized for 3/8" bolts and are spaced 18" apart.

Storage:
If the equipment cannot be installed soon after its arrival, follow these procedures:

- Store it in a clean dry place sheltered from the elements.

- Maintain the equipment on its shipping pallet and with its plastic envelope intact to minimize damage and to protect the cleanliness of the equipment. This will also tend to discourage pilfering.

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Symbols & Warning Labels

SYMBOLS:

The following symbols are used throughout the power supply. They mean the following:

This symbol means that CAUTION needs to be exercised and that the user should refer back to the manual for accompanying information.

This symbol means that there is a PROTECTIVE CONDUCTOR TERMINAL located at that spot and can be found adjacent to all protective earth terminals in the unit.

WARNING LABELS:

Warning Labels have been placed on your new equipment. If these labels become worn and need to be replaced, they can be obtained from our factory. The labels are as follows:

Label #1: Green Safety Instruction Label (NWLPart#M40015):

This label should be placed on T/R-set low voltage junction box covers.

Label #2: Danger Label (NWL Part #M40016):

This label should be placed on any removable high voltage access covers such as the external switch access panel.

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MAIN COMPONENTS

1. 1PM Power Module (1-3SCR & 4-6SCR):
1PM power module is made up of two groups of SCR power blocks. Each group contains three SCR/SCR power block devices. The first is identified as 4-6SCR. These SCRs are rated for a max. of 96aac. They hold a PIV of 1400v. These SCRs are responsible for the "Step" function of the Step/Start. They are electrically smaller than the "Start" SCRs (1-3SCR) because they will see a much less current since they are in line with the Step resistors. The other power blocks makes up 1-3SCR. These SCRs are rated for 150AAC and designed to handle the full primary current of a broadcast unit on a continuous basis. They hold a PIV of 1200v. Functionally these SCRs are responsible for the "Start" function of the Step/Start. When the "Start" function of the Step/Start is engaged, 1-3SCR will bypass the step SCRs and the step resistors and carry the full current of the load.

2. Step Resistors (1-6RES):
During the "Step" function of the Step/Start sequence, the full 480vac input power is diverted through the step resistors so as to supply reduced input voltage to the load during initial energization. A net resistance of 1Ω on each leg of the three phases have been chosen for optimum performance and minimum overshoot on the output of the broadcast power supply. Each of the 1Ω resistors is made up of two 2Ω resistors in parallel. Each of the 2Ω resistors is rated for up to 225watts of continuous power.

3. Control Board (1PC):
The Control Board is used to control and fire the SCRs so as to provide the Step/Start operation. It is also responsible for monitoring the primary lines to provide over current protection, checking for possible shorted SCRs, and preventing STEP "overuse". All of the these functions are discussed in further detail in section 6 of this manual.

4. Current Transformers (1-3CT):
1-3CT current transformers provide current feedback signals from each of the primary lines back to the control board. These CTs are rated 200/5. If the primary lines were to detect an over-current due

to a fault on the load of the S^4, the system will trip out on this fault.

5. Thermal Switches (1-3TAS)
These thermal switches are affixed directly to the step resistors. They are used to monitor the temperature of the resistors and trip if they get too high. Each switch contact is brought out to the user interface plug for the customer to monitor. The thermal switch's contacts are rated at 120vac, 5Amps inductive,
120vac, 6Amps resistive.

DO NOT EXCEED switch rating. If necessary, use an auxiliary relay to drive your interlock circuit. If inductive loads are to be switched , the user may want to install an MOV across switch.

6. Thermal Switch (4TAS)
This thermal switch is attached directly to the SCR's heatsink. It is used to monitor the temperature of the SCRs and trip if they get too high. The switch contacts are brought out to the user interface plug for the customer to monitor. The thermal switch's contacts are rated at 125vac, 15Amps resistive
250vac, 10Amps, resistive
30vdc, 1A
120vac FLA 5.8Amps inductive
240vac FLA 2.9amps

DO NOT EXCEED switch rating. If necessary, use an auxiliary relay to drive your interlock circuit. If inductive loads are to be switched , the user may want to install an MOV across switch.

7. Blower:
Cooling of the key internal components is achieved through the use of an internal air blower. This 97mm squirrel cage type blower pulls cool air into the enclosure via the two sets of slots on the front of the enclosure and discharges the heat losses out the top. The blower is rated @ 115vac and delivers as much as 120CFM. The user is required to provide the 115vac power necessary to run the blower at the user interface plug.

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INSTALLING THE UNIT

1. Verify the rating

• The maximum fault capability of the power system at the point of installation should be verified and must not exceed the short-circuit rating of the unit.

• Do not exceed the ratings specified on the unit nameplate or load system nameplate.

2. Location & Mounting

The S^4 has been designed to be electrically touch safe and can be mounted by itself as a stand alone device. However, it has been designed with the intention to be housed within another enclosure as a component within a system. The S^4 is designed to be mounted in an enclosed area such as the transmitter equipment of a broadcast site. The S^4 is designed to be mounted vertically with the slotted air intake holes facing forward and the heated exhaust discharging upwards. Four slotted holes have been provided at the top and bottom of the aluminum chassis to accept 1/4" bolts for mounting the unit.

• Follow the equipment outline drawings to determine the location of the mounting bolt holes and conduit locations.

• Allow for adequate area around the unit for power cable wiring and air cooling intake and exhaust.

3. Grounding

The unit must be grounded in accordance with the National Electrical Code (NEC) before making any incoming power connection. If a main ground bus is furnished, make the ground connection to this bus. If there is no ground bus, all equipment should be connected in such a way as to ensure a continuous grounding path. There must not be a break in the ground wire connecting all equipment to earth ground, unless a ground bus is used as an extension of the wire. This would allow equipment to be removed without breaking the ground.

The following may be used as a general guide to equipment grounding in conjunction with NEC recommendations. It specifies which NEC Article applies to grounding for this type of equipment.:

a. The grounding electrode conductor (ground wire) must be sized in accordance with NEC 250-94 and should be run from the grounding electrode to the S^4's ground terminal. See also NEC 250-91 (a) and 250-92 (a).

(The incoming ground connection on the S^4 should be made at the 10/32" grounding stud provided at the top mounting flange centered between the two mounting holes.)

b. A main bonding jumper should be installed from the incoming grounded connector bus (neutral) to the ground bus or designated grounding point. If a jumper is not furnished, one having a size in accordance with NEC 250-79 (c) should be used.

c. Steps (a) and (b) should effectively connect together the grounding electrode, the S^4's frame, all outgoing equipment grounding conductors and the grounded neutral bus of the system.

d. No connection should be made to ground on the load side of any neutral disconnecting line or any sensor used for ground fault protection. No connections should be made between outgoing grounding connectors and the neutral.

Note that this is only a guide. There may be other Codes which apply to grounding. It is up to the installer to ensure that the unit meets all applicable codes.

4. Making Input Power Connections

Before proceeding with the installation, familiarize yourself with the electrical schematic.

Now that all preparations have been made, it's time to begin connecting the S^4 to the incoming power.

• The first step is to route the incoming power cables to the top of the S^4 unit where the input terminals and grounding

stud are located. Observe minimum bending radius for the type of cable used.

• Power cables should be braced and/or laced to withstand short circuit forces wherever such cables are unsupported.

• Power cables should be adequately sized to carry the full load current in accordance with NEC requirements, and have an adequate voltage rating.

• Cables should be dressed and terminated as appropriate to the voltage class and cable manufacturer's recommendations.

• Be sure to replace any access covers, barriers, partitions, etc. that were temporarily removed during installation.

• Check the power source impedance. For proper IOT operation, the power source impedance should be less than or equal to 2%. The user must also install a Circuit Breaker inline with the power supply. This circuit breaker should be rated for the amount specified on the broadcast power supply. The instantaneous trip setting should be 10X rated and the interrupting current rating should be a minimum of 25KA at 480VAC.

• It is also recommended that the user install inline semiconductor type fuses and an inline contactor as shown on the master S^4 system schematic. The contactor will provide a means to shutdown the system upon receiving a fault command generated by the S^4 control Bd.

• Input power connections are to be made at the 3 pole terminal receptacle located at the top right of the S^4 unit. Connect the A, B, & C phases of the incoming power to the "L1", "L2", & "L3" input terminal receptacle. This three pole power input plug is manufactured by Anderson Power Products and requires the corresponding plug to mate with it. The receptacle and the plug are the exact same part. The receptacle/plug is made up of the following parts:

Conn. Housing - Anderson Power Prod. # 1321G1
Conn. Pins - Anderson Power Prod. # 1319
Conn. Mtg Clip - Anderson Power Prod. # 1464G2

• Connect the incoming ground wire to the 10-32 grounding stud provided on the top mounting flange centered between the two mounting holes.)

(Incoming phase rotation is not crucial to the S^4 for proper operation)

5. Making Output Power Connections

Now that incoming power connections have been made, it's time to connect the S^4 to your Power Supply.

• The first step is to route the incoming power cables to the top of the S^4 unit where the output terminals are located. Observe minimum bending radius for the type of cable used.

• Power cables should be adequately sized to carry the full load current in accordance with NEC requirements, and have an adequate voltage rating.

• Output power connections are to be made at the 3 pole terminal receptacle located at the top left of the S^4 unit. Connect the X1, X2, & X3 phases from the Broadcast power supply to the "T1", "T2", & "T3" terminal receptacle. This three pole power input plug is manufactured by Anderson Power Products and requires the corresponding plug to mate with it. The receptacle and the plug are the exact same part. The receptacle/plug is made up of the following parts:

Conn. Housing - Anderson Power Prod. # 1321G1
Conn. Pins - Anderson Power Prod. # 1319
Conn. Mtg Clip - Anderson Power Prod. # 1464G2

(Phase rotation of the T1-T3 power cables is not crucial to the S^4 for proper operation)

*** THE S^4 UNIT IS NOT DESIGNED TO BE WIRED INSIDE THE DELTA OF THE BROADCAST POWER SUPPLY PRIMARYS. IT MUST BE WIRED "IN-LINE " WITH THE INCOMING POWER.***

6. Control Connections (User Interface Plugs)

All 120vac and low voltage control signals to and from the S^4 are terminated at two MAT-N-LOK® interfacing plugs. Both plugs and are located on the top of the unit. The first plug is labeled J11 and is a 15 pin connector. The second is a 9 pin plug and is labeled J12. Each plug requires the use of female mating sockets and a MAT-N-LOK® crimping tool to properly interface with the system.

Amp's Part Numbers:

9 Pin MAT-N-LOK® Plug = AMP#1-480706-0 (NWL#P27006)
15 Pin MAT-N-LOK® Plug = AMP#1-480710-0 (NWL#P27022)
MAT-N-LOK® sockets:
18-24awg wire socket (female) - AMP#350689-1 (NWL#P10004)
14-16awg wire socket (female) - AMP#350919-3 (NWL#H18901)

The following connections and wire types should be made to the interfacing plugs for full control of the S^4:

J12 Plug

Pin Conn.	Function	Use Wire Type	Operation
J12-1,2	Fan Power & Electronics power	Twisted #16awg, MTW or Equiv.	Apply 120vac to energize the internal blower and electronics. 100VA total required. External fusing required. 1 = Hot 2 = Neutral
J12-6,7	Fault Trip AC Solid State Relay Output Module	Twisted #16awg, MTW or Equiv.	This output indicates that one of two faults have tripped (OTT or OCT). Switch rated for 120vac, 3A max. The output is N.C. and opens on fault. **
J12-5,8	Jumper wire	Twisted #16awg, MTW or Equiv.	This is jumper wire placed on the back of the MAT-N-LOC plug to allow the user to easily place the J12-5,8 contactor trip output and contactor control power in series

** This triac output is typically wired in series with the main contactor and will trip it off line if there is a fault condition

J11 Plug

Pin Conn.	Function	Use Wire Type	Operation
J11-7,8	1-3TAS	Twisted #16awg, MTW or Equiv.	These thermal switches will open if the 1-3RES step resistor gets too hot. All three TASs are wired in series. See section 4 of manual for ratings
J11-9,12	4TAS	Twisted #16awg, MTW or Equiv.	This thermal switch will open if the SCR heatsink gets too hot. See section 4 of manual for ratings.
J11-10,11	Fault Trip indication	#18 or 20awg twisted shielded pair	For external remote indication that the control board has detected and shutdown on either an OCT or OTT fault. Circuit is N.C. and opens on a fault. Optocoupler output. 100ma load max, 50vdc max. 10 is (+) and 11 is (-). Pull back shield.
J11-13,14	Start command	#18 or 20awg twisted shielded pair	To initiate the "Start" function, apply a +5vdc signal. Input is to an optocoupler, (470 ohm input z). 13 is (-) and 14 is (+). 10mA required. Pull back shield

Presently, the configuration of this unit is set so that the enable signal at the user's interface plug, J11-13 & 14, must be +5vdc. This configuration is set by the way the unit is internally wired between J11 on the cover and J10 on the board. However, unit is designed to accept other input levels for the enable signal. If the user required a different input voltage for the enable signal, the wiring between J11-13,14 and the J10 plug on the board could be changed to accommodate this. See the chart below for the pinout of the J10 plug on the board. (see section 6, "Step/Start control function" for more information on this feature)

J10 Plug

Pin Conn.	Function	Use Wire Type	Operation
J10-4,5	Step/Start command (for +5v enable signal)	#18 or 20awg twisted shielded pair	To initiate the "Start" function, apply a +5vdc signal. Input is to an optocoupler, (470 ohm input z). 4 is (+) and 5 is (-).Terminate shield at 6. 10mA required
J10-2,5	Step/Start command (for +12v enable signal)	#18 or 20awg twisted shielded pair	To initiate the "Start" function, apply a +12vdc signal. Input is to an optocoupler, (1000 ohm input z). 2 is (+) and 5 is (-).Terminate shield at 6. 10mA required
J10-1,5	Step/Start command (for +24v enable signal)	#18 or 20awg twisted shielded pair	To initiate the "Start" function, apply a +24vdc signal. Input is to an optocoupler, (2200 ohm input z). 1 is (+) and 5 is (-).Terminate shield at 6. 10mA required
J10-9	+24vdc board voltage	-	This +24vdc can be used to enable the step/start circuit. If used, the user need to place a switch between J10-1 and J10-9. The user must also connect J10-3 to J10-5.
J10-3&6	board ground	-	These ground points are used for both the shield terminations and if the user decides to use the +24vdc for enabling the step and start functions.
J10-7,8	Fault Trip indication	#18 or 20awg twisted shielded pair	For external remote indication that the control board has detected and shutdown on either an OCT or OTT fault. Circuit is N.C. and opens on a fault. Optocoupler output. 100ma load max, 50vdc max. 7 is (+) and 8 is (-). Terminate shield at 6 or 3

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UNDERSTANDING THE CONTROL BOARD.

1. Step/Start Control Function

The S^4 is designed to automatically perform the Step and Start sequence routine by simply providing an enable signal. The user has the option of providing either a +5, +12, or +24vdc input signal to turn the unit on. If the user decides to provide a +5vdc enable signal, they need to input the +5vdc signal into J10-4&5. If the user decides to provide a +12vdc enable signal, they need to input the +12vdc signal into J10-2&5. If the user decides to provide a +24vdc enable signal, they need to input the +24vdc signal into J10-1&5. (see section 5 for wiring details). Whichever input signal is chosen, the signal must be maintained to keep the unit in the "ON" state. Removing the enable signal will shutdown the unit. The user also has the option of utilizing the board +24vdc and ground pins at the J11 plug to feed the enable signal. This is useful if the user does not have an enable voltage signal and wants to turn the unit on and off via a dry contact closure or high speed 0electronic switch. If this mode is chosen, the user should jumper pins J10-6 to J10-5. The user's switch should then be placed between J10-9 and J10-1.

Jumpers JP1 & JP2 on the control board should be in position "A" when inputting either the +5, +12, or +24vdc signal as discussed above. Position "B" on the jumpers is solely for those users that have systems where traditionally the +5vdc command signal originally went to J10-1 & J10-2.

(This unit is internally wired so that the required enable signal at J11-13,14 on the outside cover is +5vdc. Jumpers JP1 & JP2 on the control board should be in the "A" position.)

The nominal Step time is factory set for approx. 350msec (290msec - 410msec) by R23 on the board. During this time the Step SCRs are energized and providing 480vac line power to the broadcast power supply through low resistance resistors so as to provide the unit with it's reduced input voltage for a soft power up. After the 300msec time out, the board will command the Start SCRs to turn on and the Step SCRs to turn off. Now full power is diverted to the primary of the broadcast supply. To inhibit the

SCRs and turn off power to the broadcast, simply remove the enable to the Start input.

2. Fast Shutdown
One of the key benefits to the S^4 is the ability to shut down the power to the broadcast unit in less than 1/2 of a cycle (8.3msec). To inhibit the system at any time, the user must remove the enable signal to the Start input. This input should not only be connected to the user's On/Off controls, but interlocked with their crowbar shutdown circuit so as to take full advantage of the fast shutdown.

3. XSTEP/TIME Trip
One of the safety features within the S^4 electronics is the XSTEP/TIME trip circuit. This circuit prevents the user from turning the unit on too many times in a short period of time. The reason for this is because the step resistors are sized for a very low duty cycle, since the Step function only lasts for a very short time and is used infrequently, and will burn up if they are turned on and off repetitively. Therefore, the XSTEP/TIME trip circuit will not permit the user to enable the system more than 3-4 times every couple of seconds. If the circuit trips, the red LED (D29) labeled "XSTEP/TIME" will turn on and the system will inhibit. After the circuit trips, it will automatically reset itself within the next 5-10 seconds and the light will go out.

4. OTT Trip
In the unlikely event that there are shorted SCRs within the S^4, there is a circuit that will detect it and shut down the contactor. (provided the contactor is wired into output fault relay) If the system detects current through the CTs while the enable signal is in the off state, the system will detect this, inhibit the SCRs, and the red LED (D33) labeled "OTT" will turn on. The 120vac power must be cycled off for at least (2) seconds to reset this fault.

5. OCT Trip
In the event that the system detects excessive current on the primary lines, the electronics will detect this and inhibit the system. If this occurs, the red LED (D35) labeled "OCT" will turn on. Once the fault is cleared, the system will reset when the start enable is removed and then reapplied. This trip function level is set using the R53 pot on the control Bd.

6. Contactor Control
An external contactor should be used to control the input line voltage of the step/start controller. If there is either an OTC or an OTT fault, an auxiliary AC solid state relay (U14 Triac) is toggled

on the board. The output of this solid state relay originates at the J9 plug on the board and is then brought out to the J12 interface plug. This SSR can be used to shut down the contactor. If the user decides to use it to shut down the contactor, they simply need to wire the output is series with the contactor's 120vac coil. The output is N.C. and will open during a fault.

It is recommended that this feature be used to shut down the contactor.

7. Fault indication

Upon a fault as indicated in item (6) above, an additional signal output is provided at J10-7 & 8. This signal can be monitored by the user to provide remote indication of an OTT or OCT fault. Just as the triac output at J9-1&2, this output is normally closed and opens on fault. The indicating device is an Optocoupler output that can switch a maximum load of 100ma max @ 50vdc. J10-7 is (+) and J10-8 is (-). The readbck signal is internally wired up to the J11 plug on the unit's cover (see section 5 and the electrical schem.). The output of the circuit can be disabled and isolated by removing the JP1 jumper on the control board.

(This unit is set up with the JP1 jumper on the control board in place)

8. Yellow LEDs (D36, D37, D39)

A voltage sensing circuit is used to monitor the 480vac voltage across each of the main Start SCRs. Each of the three sensing circuits drives a yellow LED light on the board. When the 480VAC power is applied to the S^4 and the enable signal is not yet applied, these LEDs should all be lit indicating the SCRs are properly blocking voltage. When the S^4 is enabled and the SCRs all turn on, the voltage across the SCRs essentially fall to near zero and the LEDs should go out. If the LEDs are partially lit, flicker, or only some go out, then this indicates a problem with either the SCRs or the firing board. This sensing circuit is only a diagnostics circuit used to aid in troubleshooting. It does not activate any other part of the S^4 board.

7

STARTING THE POWER SUPPLY

1. ***After installation but before energizing the S^4 for the first time, double-check the following:***

Make sure that all electrical wiring and power connections are correct and have not become loose in transportation.

Make sure that all metal chips, scrap wire and other debris left over from installation have been cleaned out before start-up.

Make sure the unit is cleaned with a lint-free brush or a vacuum cleaner if there is an appreciable accumulation of dust or dirt.

Make sure you have a supply of spare parts, fuses etc. on hand before start up.

Check field wiring for clearance to live busses and physical security to withstand effects of fault current.

Check all grounding connections.

Record any changes made to circuit diagrams during installation.

2. Procedural Start-up:

The following sequence should be used to start the system:

1) Engage 3PH power from the system's up stream circuit breaker.
2) Apply 120vac control power to the system.
3) If the contactor has not automatically energized when the 120vac power is applied, apply 120vac to the coil of the contactor.
4) Verify that the S^4's fan is running and discharging air at the top of the unit.
5) If there are no fault signals or fault lights, apply the Start enable.

6) The system will now Step/Start the 3PH power to the broadcast load.

3. Procedural Shut-down:

The following sequence should be used to shut down the system:

1) First remove the Start enable. This will inhibit the SCRs and remove 3PH power from the primary of the broadcast load.
2) Disengage the 3PH power from the system's up stream circuit breaker.
3) Remove the 120vac control power to the system.
4) The system is now shut down.

8

ROUTINE MAINTENANCE PROCEDURES

*****ALL MAINTENANCE SHOULD BE DONE WITH POWER OFF. *****

The power S^4 should be inspected approximately every 12 months.

Inspection
Inspect the unit periodically for any damage to the parts or buildup of debris or dirt. Double check that all electro-mechanical connections are still tightly fastened. Double check that all mounting hardware is still tightly fastened

Cleaning
Remove any foreign matter from within the unit. Dirt on the resistors and heatsink can decrease heat dissipation and cause the unit to overheat.

9

TROUBLESHOOTING POTENTIAL PROBLEMS, CAUSES AND CORRECTIVE ACTIONS

No Output Voltage

No output voltage after Step/Start is initiated

Action:

- Verify presence of primary voltage on all 3 phases.
- Verify presence Start enable signal.
- Verify all fault lights are out.
- Verify presence of 120vac control power.
- Verify the signal strength and voltage level of Start enable signal.

No Output Current

No output current, but voltage is present after Step/Start is initiated

Action:

- Check all output connections.
- If voltage is present on primary, check for open output connections.
- Check for open output connections on the load to the broadcast supply.

External Contactor Doesn't Pull In

Contactor does not respond.

Action:

- Verify presence of 120vac control power.
- Verify 120vac control signal to the coil of the contactor.
- Verify that there are no fault lights on if the contactor is wired into the board's fault circuit
- Check that the wiring of the 120vac contactor signal to and from the user is correct with respect to J12 plug and J9 plug pinouts.
- Verify that U14 SSR on the board is functional.

Too High Inrush

Inrush on load is too high.

Action:

- R27 on control Bd mal-adjusted and the Step timing is too quick.
- Verify Step SCRs are turning on and board is not malfunctioning.
- Check broadcast unit load is not shorted.
- Check broadcast unit has not failed

4TAS Over-Temperature Indicator Trips

The 4TAS thermal switch on the SCR heatsink trips.

Action:

- Measure actual line current draw.
- Verify balance line voltage and current.
- Check ambient temperature.
- Verify that the unit is getting the 100CFM of required cooling air to the air intake plenum.

1-3TAS Over-Temperature Indicators Trips

One or more of the 1-3TAS thermal switches on the step resistors trips.

Action:

- Measure actual line current draw.
- Verify balance line voltage and current.
- Check ambient temperature.
- Verify that the unit is getting the 100CFM of required cooling air to the air intake plenum.
- Is the S^4 possibly being operated too many times in a short period of time?
- Is the S^4 possibly being cycled too many times in a short period of time due to automatic "retry" circuitry from the crowbar shutdown electronics in the transmitter?

D33 "OTT" Light is on

OTT light turns on just before or at the time the unit is being started.

Action:

- With all power off, ohm across the SCRs and check for a short.
- Measure actual line current draw.
- Verify balance line voltage and current.
- Prior to enabling the unit, are any of the three yellow LEDs on the board lit. This would indicate a shorted SCR.

D35 "OCT" Light is on

The OCT light turns on just after the S^4 is turned on.

Action:

- This indicates an over-current in the primary lines. Measure actual line current draw.
- Verify balance line voltage and current.
- Check broadcast unit load is not shorted.
- Check broadcast unit has not failed

D29 "X-STEP/TIME" Light is on

The X-STEP/TIME light turns on.

Action:

- This indicates that the unit is being operated too many times in a short period of time.
- Is the S^4 possibly being operated too many times in a short period of time?
- Is the S^4 possibly being cycled too many times in a short period of time due to automatic "retry" circuitry from the crowbar shutdown electronics in the transmitter?

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SUPPLEMENTS

The following supplements are enclosed in the back of this manual for reference:

1. Master System Electrical Schematic ……..……C113183
2. D25170 Control Board Electrical Schematic ……B116378
3. S^4 Physical Outline .....……B113080

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RECOMMENDED SPARE PARTS LIST

The following is a list of recommended spare parts that should be on hand during startup and operation of the Step Start unit.

Item Description	NWL PART#	Part Reference	Recommended QTY	Price per pc.
Step Start control Board	D25170-01	1PC	1	Call for price
Current Transformer, 200:5A	H14202	1-3CT	1	Call for price
5uF Blower Cap	H16035	C1	1	Call for price
2 ohm, 225w, step Resistor w/ TAS	113295	1,3,5RES	3	Call for price
2 ohm, 225w, step Resistor	H95340	2,4,6RES	3	Call for price
SCR/SCR block, 250amp	P29042	1-3SCR	3	Call for price
SCR/SCR block, 96amp	P29045	4-6SCR	3	Call for price
SCR Snubber Bd.	D25175	-	1	Call for price

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WARRANTEE STATEMENT

WARRANTIES & GUARANTEES

NWL agrees to correct any defect in material and workmanship of any equipment furnished by it to purchaser which may develop under normal and proper use (corrosions excepted) within the quoted warranty period of said equipment by repairing the defective part or parts or by replacing the same f.o.b. place of manufacture; provided, however, that any equipment not of NWL's design or manufacture is sold only under regular guarantee and responsibility of the maker and is guaranteed by NWL only to such extent.

NWL Guarantee is conditioned upon the following:

a. That purchaser provide the Normal Operating conditions for said equipment. If applicable, control setting data as outlined in operator's manual must be submitted to NWL within two (2) weeks after first energization.

b. This warranty is predicated on the basis that any storage will be sheltered from the elements in a cool and dry location, handling being such that equipment is in first-class condition prior to start-up, and will be used within its specified design limits. Failure to meet these requirements will void warranty in its entirety.

NWL will not be liable for any charges incurred by Purchaser or for its account in correcting defects or making changes in the equipment to conform to this agreement, unless NWL is given reasonable time to inspect and correct such defects or make the necessary changes. Any repairs or changes not authorized by NWL in writing voids the warranty.

NWL will not be liable for any consequential or special damages, loss or expense arising in connection with the use of, or inability to use, its equipment for any purpose whatsoever. NWL's liability, under no circumstances, will exceed the contract price for the goods returned as defective or unsuitable.

THE FOREGOING ARE NWL'S SOLE WARRANTIES AND GUARANTEES WITH RESPECT TO THE EQUIPMENT TO BE FURNISHED UNDER THIS PROPOSAL. NWL MAKES NO OTHER WARRANTIES OR GUARANTEES OF ANY KIND WHATEVER, EXPRESSED OR IMPLIED: AND IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (WHICH EXCEED THE ABOVE OBLIGATIONS AND SPECIFICATIONS AS QUOTED) ARE HEREBY DISCLAIMED BY NWL AND EXCLUDED