

# SCADA Units Service Manual

## References:

Design Report Regional HF Station 20161121 and  
QHUG HF Remote Station SCADA Design Report 20161121.

## SCADA Overview

SCADA means System Control and Data Acquisition and refers to the remote Control and monitoring of the station's systems.

The SCADA controls and monitors the power systems, antenna selection and directivity, and the site security and environment. The SCADA system does not include the **Remote Rig** system that controls just the ICOM Transceiver functions of voice and data.

SCADA is best described as two separate sub-systems:

**Control-** also sometimes called: "Remote Control" or "Forward Control". This system is designed with 36 control functions

**Supervisory** – also sometimes called "Site Data" or "Telemetry" or "Status Indications". This system is designed with 36 of these indications

## Control Protocol used

The control system works on a momentary closing of a contact to ground. (Ground Active or Logic "0"). This protocol means an "on" command always has to be a separate command from an "off" command.

This pulse concept for all controls is described in more detail in the documentation for each of the individual units that are subject to remote control.

For example: to turn the power "on" to the linear amplifier (i.e. The 24V to 230V inverter), a momentary grounding of an "on" pin is required (at either end of the remote control system). To turn the linear amplifier "off" a momentary grounding of a separate "off" pin is required. (again at either end of the control system.)

This approach means that the functions subject to remote control can be operated from either the base node or at the HF Site quite independently of each other. The only exception to this rule is the way the Transmit "on" function works. These are described elsewhere in the Station manuals.

## Supervisory Protocol

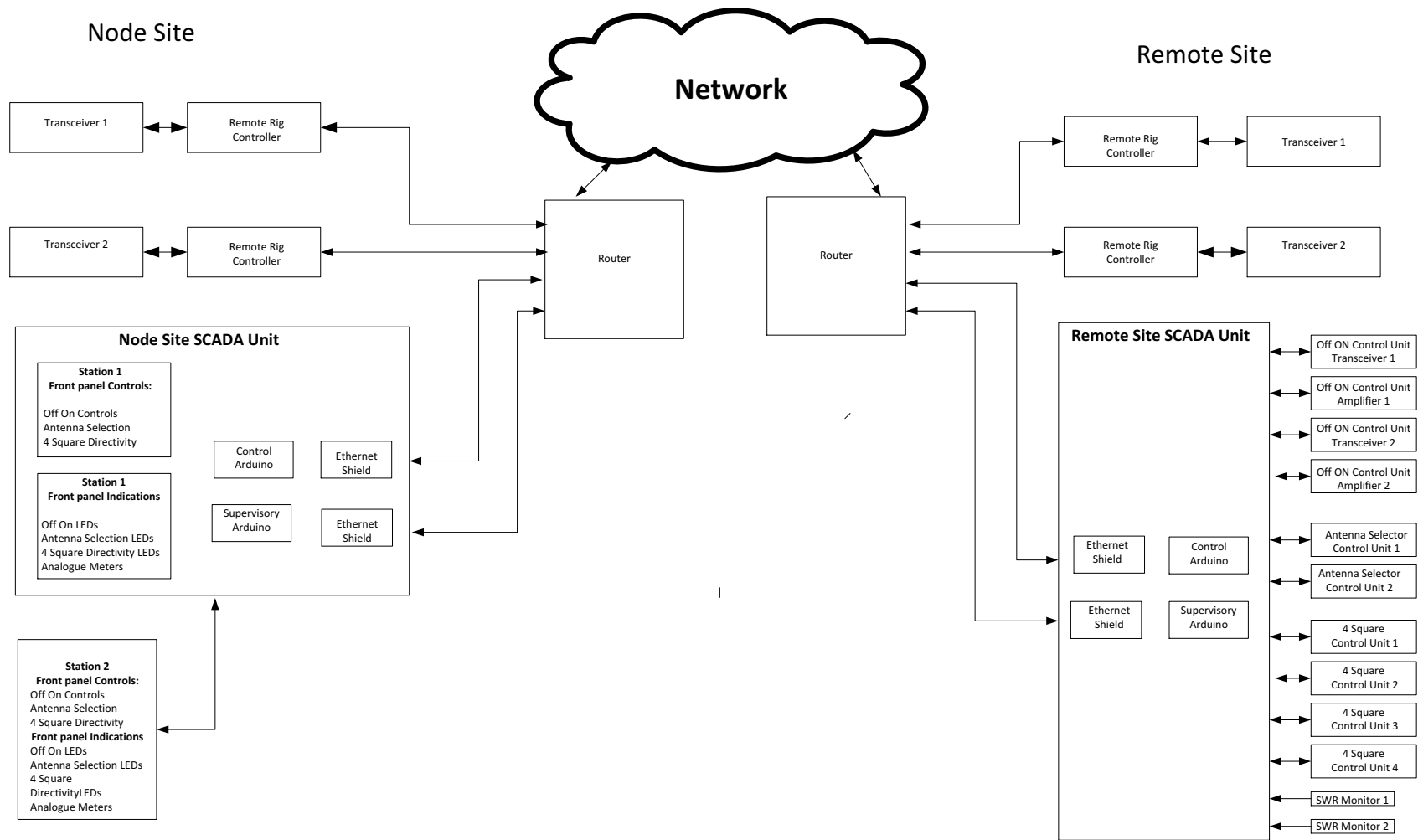
The supervisory part of the SCADA is designed to monitor the status of many different points in the Station's systems. Status indications are of a digital nature and require a sustained closing of a contact to ground (ground- active or logic "0"). An open contact (high) or logic 1 is the default condition for no indication.

Analogue Indications are provided for RF Power and VSWR for each Transceiver/Linear Combo. This also described under **VSWR Monitors**.

In addition some analogue indications around the Solar Power Generation and primary battery supply Voltage and load current are also provided.

The indications used in this design are based on what an operator would want to see to gain assurance that the station is operating correctly and to assist with trouble shooting in the event of a major malfunction.

Drawing 10 Schematic of SCADA System



## **Service Manual in two Parts**

There are two SCADA units and this Manual is in two parts:

Part 1: Base Node SCADA Unit

Part 2: Site SCADA Unit

## **Part 1 – Base Node SCADA Unit**

### **Base Node Unit Overview**

This Base Node Unit is a unit of operating kit intended for use alongside a remote enabled Transceiver. It is intended for placement at the Node Site and provides a direct interconnection with the corresponding Site SCADA Unit located at the remote site as shown in the Schematic of the SCADA system.

From the outset the system design for the SCADA system between the Base Node and the remote site was intended to be a “closed system” that avoids the use of internet enabled computers in this part of the system. This may seem to be a departure from the more common practice of Hams building their own private remote systems where everything is integrated on to a computer in their shack. This system was developed in a staged robust manner so that two or more individual stations can be operated remotely and independently. It is envisaged that a system of session sharing and resource allocation will be subsequently developed that interfaces between the Node Site and “the World” by whatever means and sophistication that is appropriate.

Remote control uses mechanical push-button switches at the Base Node site to control various functions at the Remote HF Station site. The ability to connect a computer in addition with some sort of GUI is included by providing suitable connectors, although the specific details of such hardware are not considered in this design. The connection of glass screens or sharing with the world are envisaged as a later addition.

The supervisory system is designed with its own display components separately from the remote control. It is acknowledged however that both control and Supervisory data may be handled by a common bi-directional data transfer system.

The status of the various parts of the remote station points being monitored are displayed by illuminated panel LEDs or analogue meters. These indications are displayed at the Base Node site on the control panel adjacent to their associated control buttons where this is practical. (For example the “Transceiver On” LED indicator is adjacent to the “on” push button etc.).

All control commands are sent to the remote site as a momentary pulse (20 to 100ms) at the time of changing the state of the unit being controlled. This means the most of the time there are no control commands being sent and no data is being sent to the remote site to make the system operate.

On the other hand any supervisory indications (include “off” status) are originated at the remote site as an “active low” on the relevant input to the supervisory and are sustained for as long as that indication state exists.

At the Node Site the SCADA Unit serves as an interface and a distribution point for connections to other devices. This unit is viewed as integral to the whole system and not likely to be replaced as the development of the station occurs to allow other devices such as computers and glass screens and a system sharing system to be added to the system.

Consideration of peripheral computer systems has been included by making connection points available for them by way of three DB 37 pin sockets: SKA, SKB, and SKC on the back of the Base Node SCADA Unit

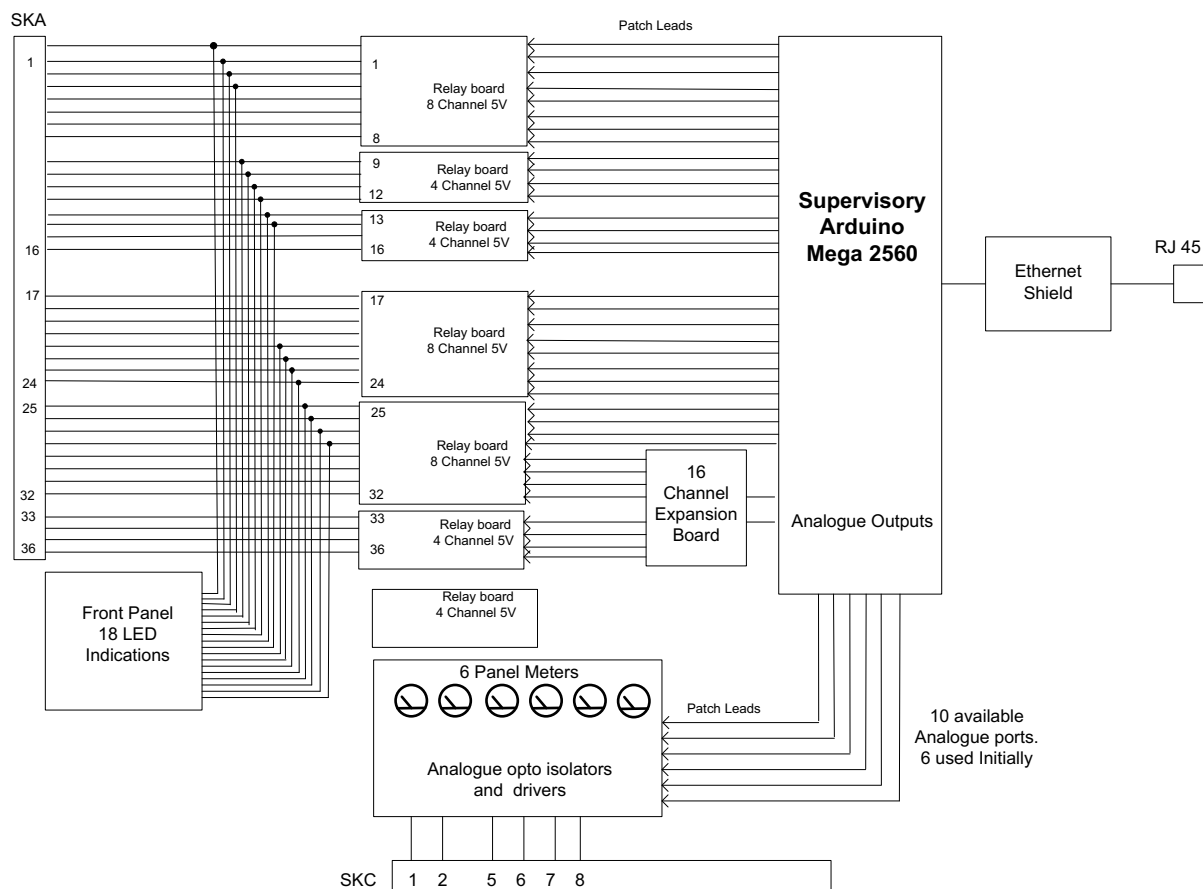
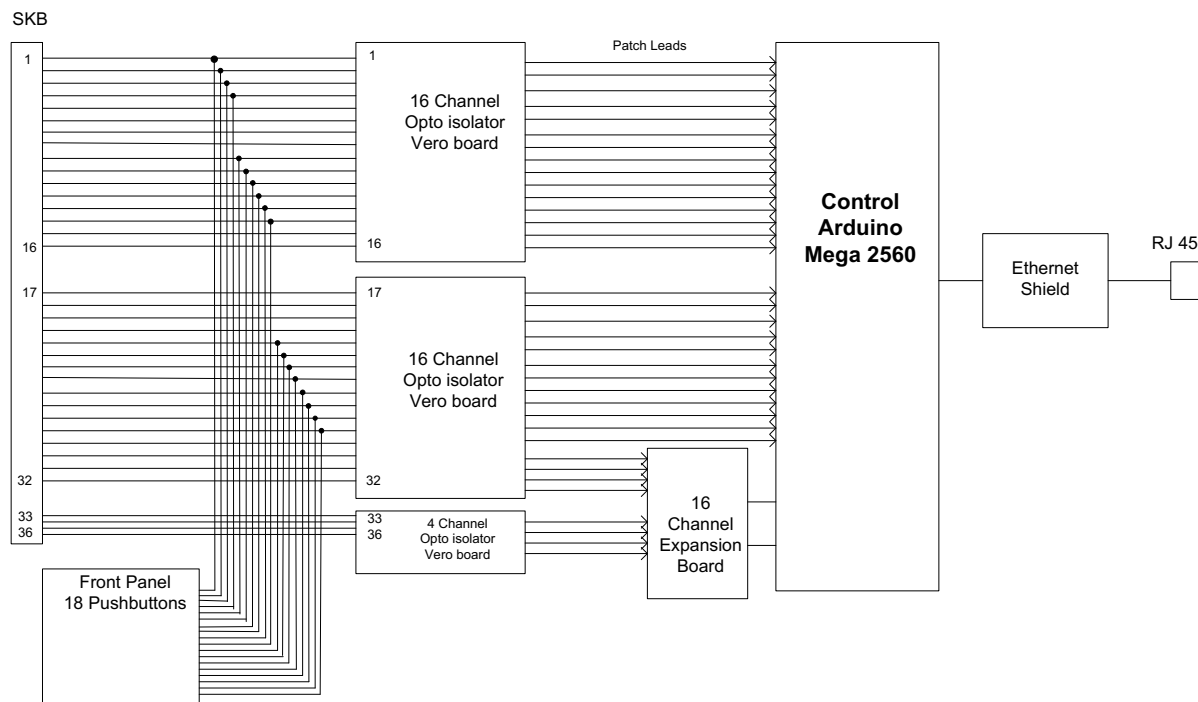
The Base Node SCADA Unit has provision for an alternative system for communication with the Remote site. Connection points are available by way of three DB 37 pin sockets: SKA, SKB, and SKC on the back of the unit.

#### **Base Node SCADA Unit Block Diagram**

The block diagram of the Base Node SCADA Unit follows next page and shows both Control and supervisory functions

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**Drawing 11 Base Node SCADA Unit  
Block Diagram**



## Remote control

The Control Functions that are facilitated by the Base Node SCADA Unit include:

On- Off control of transceivers and Linear Amplifiers

Antenna Selection for each of the two Transceiver -Linear Combos

Directivity switching of up to 4 Four Square arrays

Excluded from this manual is the **Remote Rig** system that controls just the ICOM Transceiver functions of voice and data.

The Control Functions are listed in detail in the tables below:

### Base Node SCADA Unit: Remote Controls:

SKB Pin	Use	Command	Base Node Input Logic	Remote Site Output Logic	Description
	<b>Power Controls</b>				
1	Transceiver 1	TXCVR On	1=Open 0=Active	1= Off 0= ON	This turns the 24-12V DC Voltage buck 1 from idle to full on.
2	Transceiver 1	TXCVR Off	1=Open 0=Active	1= Off 0= ON	This turns the 24-12V DC Voltage buck 1 to idle.
3	Linear Amp 1	LIN 1 On	1=Open 0=Active	1= Off 0= ON	This turns the 24V DC to 230V AC Inverter 1 to ON.
4	Linear Amp 1	LIN 1 Off	1=Open 0=Active	1= Off 0= ON	This turns the 24V DC to 230V AC Inverter 1 OFF.
5	Transceiver 2	TXCVR On	1=Open 0=Active	1= Off 0= ON	This turns the 24-12V DC Voltage buck 2 from idle to full on.
6	Transceiver 2	TXCVR Off	1=Open 0=Active	1= Off 0= ON	This turns the 24-12V DC Voltage buck 2 to idle.
7	Linear Amp 2	LIN 2 On	1=Open 0=Active	1= Off 0= ON	This turns the 24V DC to 230V AC Inverter 2 to ON.
8	Linear Amp 2	LIN 2 Off	1=Open 0=Active	1= Off 0= ON	This turns the 24V DC to 230V AC Inverter 2 OFF.
	<b>Antenna Selector 1</b>				
9	Position A1	S1 pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
10	Position A2	S1 pos 2	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
11	Position A3	S1 pos 3	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5

12	Position A4	S1 pos 4	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
13	Position A5	S1 pos 5	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
14	Position A6	S1 pos 6	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5 <u>50 Ohm Load</u>
	<b>Antenna Selector 2</b>				
15	Position A1	S2 pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
16	Position A2	S2 pos 2	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
17	Position A3	S2 pos 3	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
18	Position A4	S2 pos 4	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
19	Position A5	S2 pos 5	1=Open 0=Active	01=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
20	Position A6	S2 pos 6	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5 <u>50 Ohm Load</u>
	<b>Directivity 4 Square Array 1</b>				
21	Direction NW (315°)	4S1 Pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 3 <u>NW Direction</u>
22	Direction NE (45°)	4S1 Pos 2	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>NE Direction</u>
23	Direction SE (135°)	4S1 Pos 3	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>SE Direction</u>
24	Direction SW (225°)	4S1 Pos 4	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>SW Direction</u>
	<b>Directivity 4 Square Array 2</b>				
25	Direction NW (315°)	4S2 Pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 3 <u>315°T</u>

26	Direction NE (45°)	4S2 Pos 2	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>45°T</u>
27	Direction SE (135°)	4S2 Pos 3	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>135°T</u>
28	Direction SW (225°)	4S2 Pos 4	1=Open 0=Active	1=Normal 0= Select	Ditton above <u>225°T</u>
	<b>Directivity 4 Square Array 3</b>				
29	Direction NW (315°)	4S2 Pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 3 <u>315°T</u>
30	Direction NE (45°)	4S2 Pos 2	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>45°T</u>
31	Direction SE (135°)	4S2 Pos 3	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>135°T</u>
32	Direction SW (225°)	4S2 Pos 4	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>225°T</u>
	<b>Directivity 4 Square Array 4</b>				
33	Direction NW (315°)	4S2 Pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 3 <u>315°T</u>
34	Direction NE (45°)	4S2 Pos 2	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>45°T</u>
35	Direction SE (135°)	4S2 Pos 3	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>135°T</u>
36	Direction SW (225°)	4S2 Pos 4	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>225°T</u>
37	Common Earth				Common for all 36 pins above

**Notes:**

- The numbering on the left of this table is a means of numbering the digital control functions. They are also the pin numbers for SK2 on the BASE Node SCADA Unit.
- Earlier thinking (and the hardware wiring of the 4 Square Controllers) had hand-shaking indications between these devices. This has been dropped.
- There is no PTT (TX On) command carried by this remote control system. The remote rig system carries this command.
- PTT (TX ON) command is taken from the ICOM transceiver at the remote site and used for 3 other functions:
  1. Activate the Linear Amplifier associated with that transceiver
  2. Inhibit any switching in the Antenna Selector while transmitting
  3. Inhibit any switching of 4 square array directivity while transmitting.
- PTT and Transmitting interlock details are included in the manual for the ICOM Linear Interface Unit.



## Supervisory

The Supervisory Functions that are facilitated by the Base Node SCADA Unit include:

Off-On Status of the transceivers and Linear amplifiers

Indication of which Antenna is selected to each Transceiver – Linear combo.

Indication of the direction selected for each 4 Square Array

Excluded from this manual is the **Remote Rig** system that surveils the ICOM Transceiver.

The Supervisory Functions are listed in detail in the tables below

### Supervisory Digital Indications:

SKA Pin	Use	Data Point	Remote Site Input Logic	Base Node Output logic	Description
	<b>Power Indications</b>				
1	Transceiver 1	TXCVR On	1=Open 0=Active	1 = OFF 0 = ON	Indicates 12V is supplied to the transceiver and associated units
2	Transceiver 1	TXCVR Off	1=Open 0=Active	1 = OFF 0 = ON	Indicates 12V is <u>not</u> available for the transceiver and associated units
3	Linear Amp 1	LIN 1 On	1=Open 0=Active	1= OFF 0 = ON	Indicates the 24V to 230Vac inverter is "ON".
4	Linear Amp 1	LIN 1 Off	1=Open 0=Active	1 = OFF 0 = ON	Indicates the 24V to 230Vac inverter is "OFF".
5	Transceiver 2	TXCVR On	1=Open 0=Active	1 = OFF 0 = ON	Indicates 12V available for the transceiver and associated units
6	Transceiver 2	TXCVR Off	1=Open 0=Active	1 = OFF 0 = ON	Indicates 12V is <u>not</u> available for the transceiver and associated units
7	Linear Amp 2	LIN 2 On	1=Open 0=Active	1= OFF 0 = ON	Indicates the 24V to 230Vac inverter is "ON".
8	Linear Amp 2	LIN 2 Off	1=Open 0=Active	1 = OFF 0 = ON	Indicates the 24V to 230Vac inverter is "OFF".
	<b>Antenna Switch 1</b>				
9		S1 pos 1	1=Open 0=Active	1 = OFF 0=selected	"0" = LED lit. Antenna Name selected. Indicates status at remote site
10		S1 pos 2	1=Open 0=Active	1 = OFF 0=selected	"0" = LED lit. Antenna Name selected. Indicates status at remote site
11		S1 pos 3	1=Open 0=Active	1 = OFF 0=selected	"0" = LED lit. Antenna Name selected. Indicates status at remote site
12		S1 pos 4	1=Open 0=Active	1 = OFF 0=selected	"0" = LED lit. Antenna Name selected. Indicates status at remote site
13		S1 pos 5	1=Open 0=Active	1 = OFF 0=selected	"0" = LED lit. Antenna Name selected. Indicates status at remote site
14		S1 pos 6	1=Open 0=Active	1 =Normal 0= Select	"0" = LED lit. 50 Ohm load selected at remote site
	<b>Antenna Switch 2</b>				
15		S2 pos 1	1=Open 0=Active	1 = OFF 0=selected	"0" = LED lit. Antenna Name selected. Indicates status at remote site
16		S2 pos 2	1=Open	1 = OFF	"0" = LED lit. Antenna Name selected.

			0=Active	0=selected	Indicates status at remote site
17		S2 pos 3	1=Open 0=Active	1 = OFF 0=selected	"0" = LED lit. Antenna Name selected. Indicates status at remote site
18		S2 pos 4	1=Open 0=Active	1 = OFF 0=selected	"0" = LED lit. Antenna Name selected. Indicates status at remote site
19		S2 pos 5	1=Open 0=Active	1 = OFF 0=selected	"0" = LED lit. Antenna Name selected. Indicates status at remote site
20		S2 pos 6	1=Open 0=Active	1 = OFF 0=selected	"0" = LED lit. 50 Ohm load selected at remote site
	<b>4 Square No 1 (Direction)</b>				
21		NW Selected	1=Open 0=Active	0 = OFF 1=selected	Indicates remote station selection LED on
22		NE Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection LED on
23		SE Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection LED on
24		SW Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection LED on
	<b>4 Square No 2 (Direction)</b>				
25		315°T Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection LED on
26		46°T Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection LED on
27		135°T Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection LED on
28		225°T Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection LED on
	<b>4 Square No 3 Direction</b>				
29		Reserved			Indicates remote station selection LED on
30		Reserved			Indicates remote station selection LED on
31		Reserved			Indicates remote station selection LED on
32		Reserved			Indicates remote station selection LED on
	<b>4 Square No 4 Direction</b>				
33		Reserved			Indicates remote station selection LED on
34		Reserved			Indicates remote station selection LED on
35		Reserved			Indicates remote station selection LED on
36		Reserved			Indicates remote station selection LED on
37	Common	Earth			

- The numbering on the left of this table is a means of numbering the digital control functions. They are also the pin numbers for SK1 on the BASE Node SCADA box.

### Analogue Supervisory Indications

SKC Pin	Use	Analogue Indication	Data Exchange	Description
1	4 Square 1	Balance Load Power	8 bit	Power in dummy load 10 – 100 Watts
2	4 Square 2	Balance Load Power	8 bit	Power in dummy load 10 – 100 Watts
3	4 Square 3	Reserved	8 bit	
4	4 Square 4	Reserved	8 bit	
5	Station Battery 24V	Voltage	8 bit	Volts
6		Current	8 bit	Amps
7	SWR Monitor 1	Forward	8 bit	Forward power indication
8		Reflected	8 bit	Reflected power indication
9	SWR Monitor 2	Forward	8 bit	Forward power indication
10		Reflected	8 bit	Reflected power indication
11	Solar Panel 1	Current	8 bit	
12	Solar Panel 2	Current	8 bit	
13	Building Heat	Temperature	8 bit	Building Temperature
14	Spare			

## Base Node SCADA Unit Construction and Wiring

A fundamental design rule that has been applied is: All digital inputs and digital outputs of the Arduino devices are to be electrically isolated from any peripheral devices that get connected them. In much of the published experimental circuits and applications this precaution is not made explicit and on a test bench where applications are not critical this is understandable.

The isolation provided by opto couplers and/or relays ensures a more reliable and stable operation under conditions of high RF at the remote site and the potential presence of static charges from (furniture and people) at the node site.

This design opted for the ready-made relay boards for all Arduino outputs and PC817 devices on custom boards for all Arduino inputs. The Arduino outputs use 5V relays boards that are available in combinations of 2, 4 or 8 relays per board. While these are a bit bulky they are a low cost way of achieving excellent isolation.

A different approach is used for inputs to the Arduino: Custom boards with 36 opto isolators using small devices such as the PC817 as these are more compact compared to the ready-made 5V relay boards.

Every digital input or output is available for connection to a device outside the SCADA Unit, meaning all inputs to opto couplers and all outputs at the relay contacts are wired to SKA and SKB on the unit.

### How the Base Node SCADA Unit works

Remote Controls: these inputs to the “Control Arduino” are supplied from either the front panel push button switches or a secondary station panel plugged into SKB. (Also labeled “Control”). These inputs to the Control Arduino are via the 36 opto-couplers on a custom made veroboard.

Supervisory: The supervisory indications coming back from the remote site via the network are in effect outputs from the “Supervisory Arduino” that then turn on LED indications on the front panel of the Base Node SCADA Unit via the relay boards. (a total of 36 in number) These relay indications are also wired to SKA.

Powering the relay boards in the Base Node SCADA Unit:

- All relay boards that provide Supervisory indications and are driven from the Arduino outputs derive their power from the internal 5V supply of the Unit to prevent too much loading on the Arduino.
- All control inputs from Custom opto-isolator boards to the Arduino are powered from the Arduino 5V supply that it is inputting.

### **Analogue Outputs wiring**

Analogue Outputs from the Supervisory Arduino are connected via linear opto-couplers and are used to drive the front panel analogue meters. Analogue outputs are also available on SKC

Most of these meters are in the same box as the SCADA Arduino and will probably use the Arduino common (earth). Any meters external to the SCADA box must keep the common (earth) isolated from any other earths other than the originating Arduino earth.

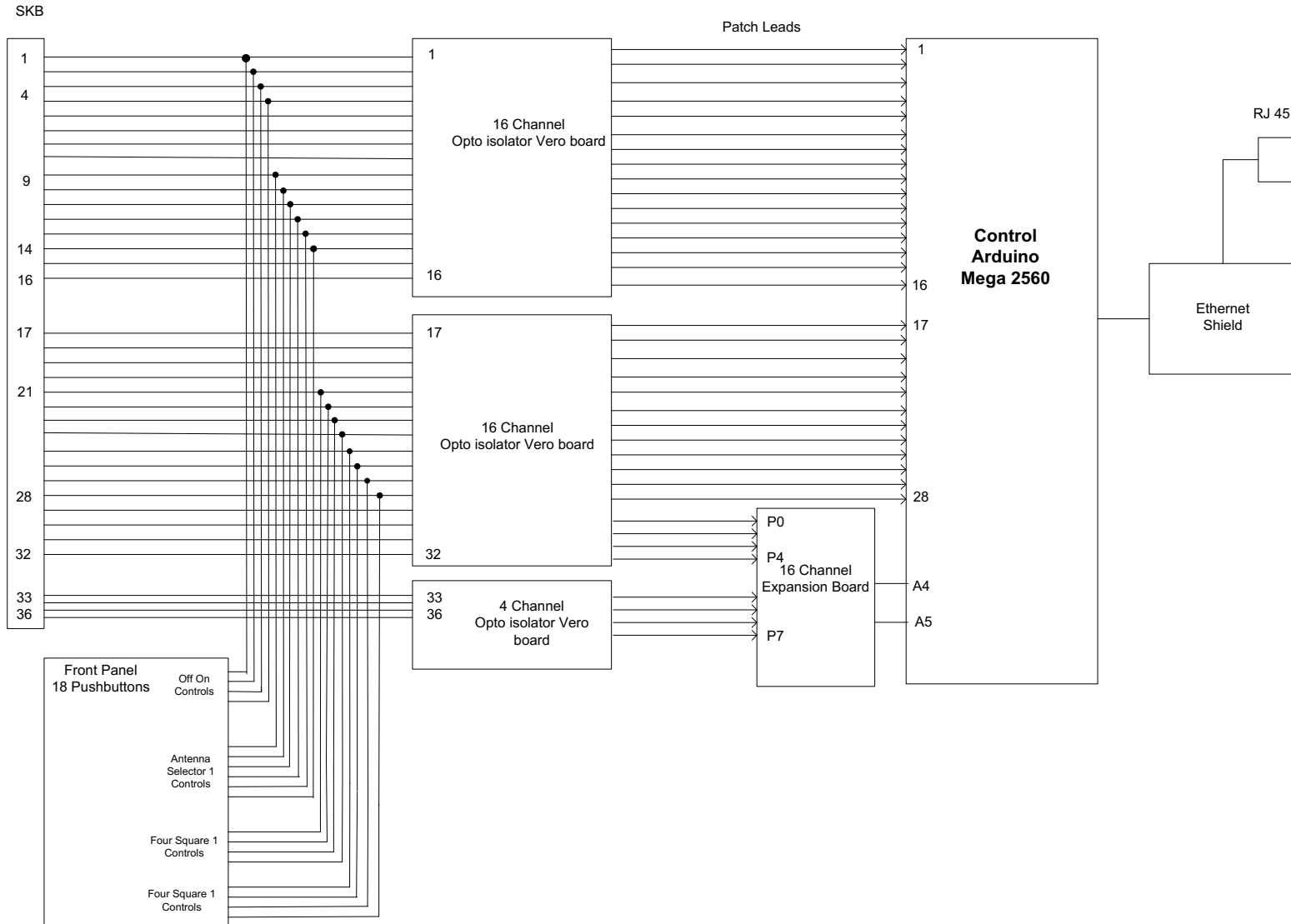
## **Block and Circuit Diagrams**

11 a

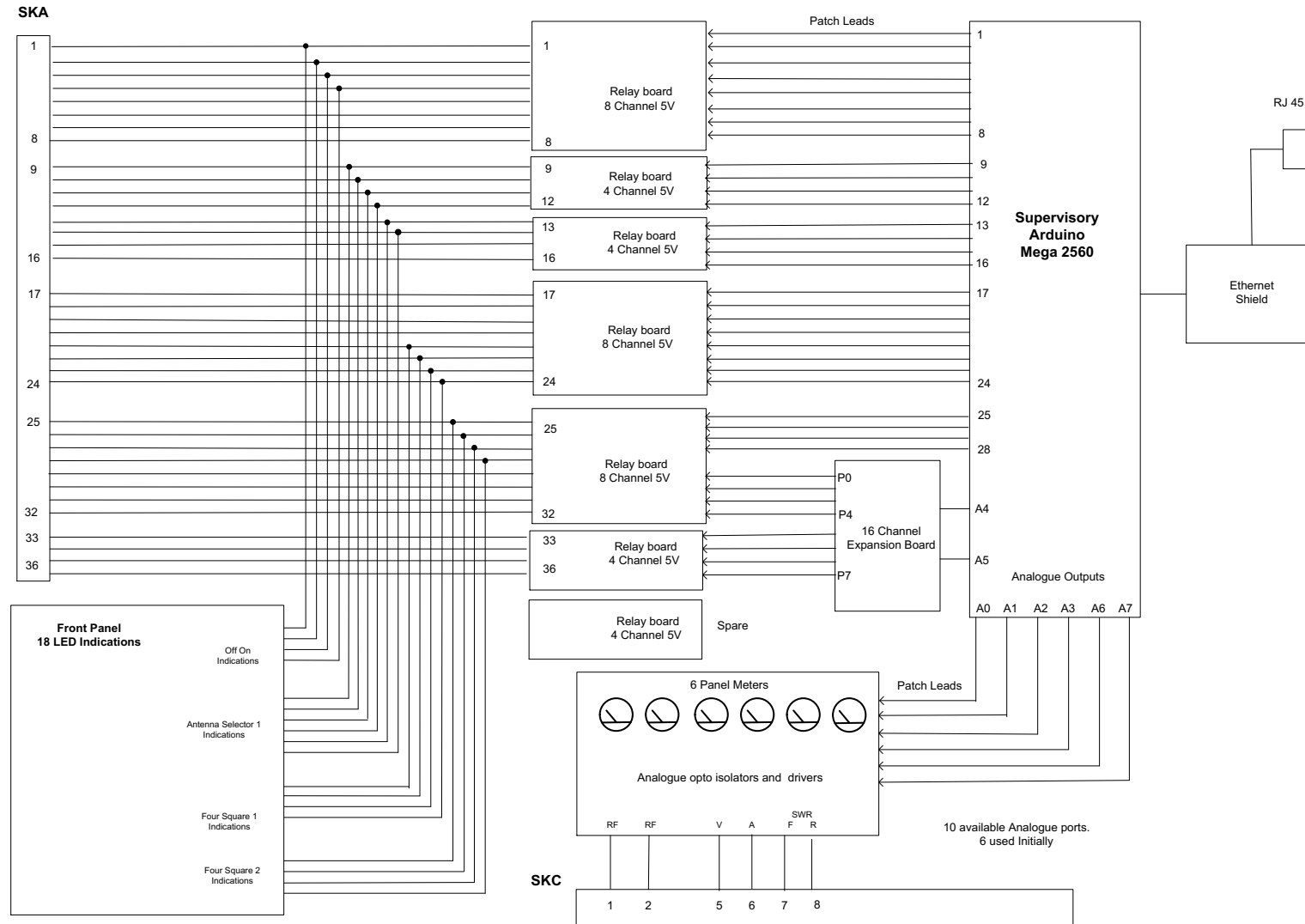
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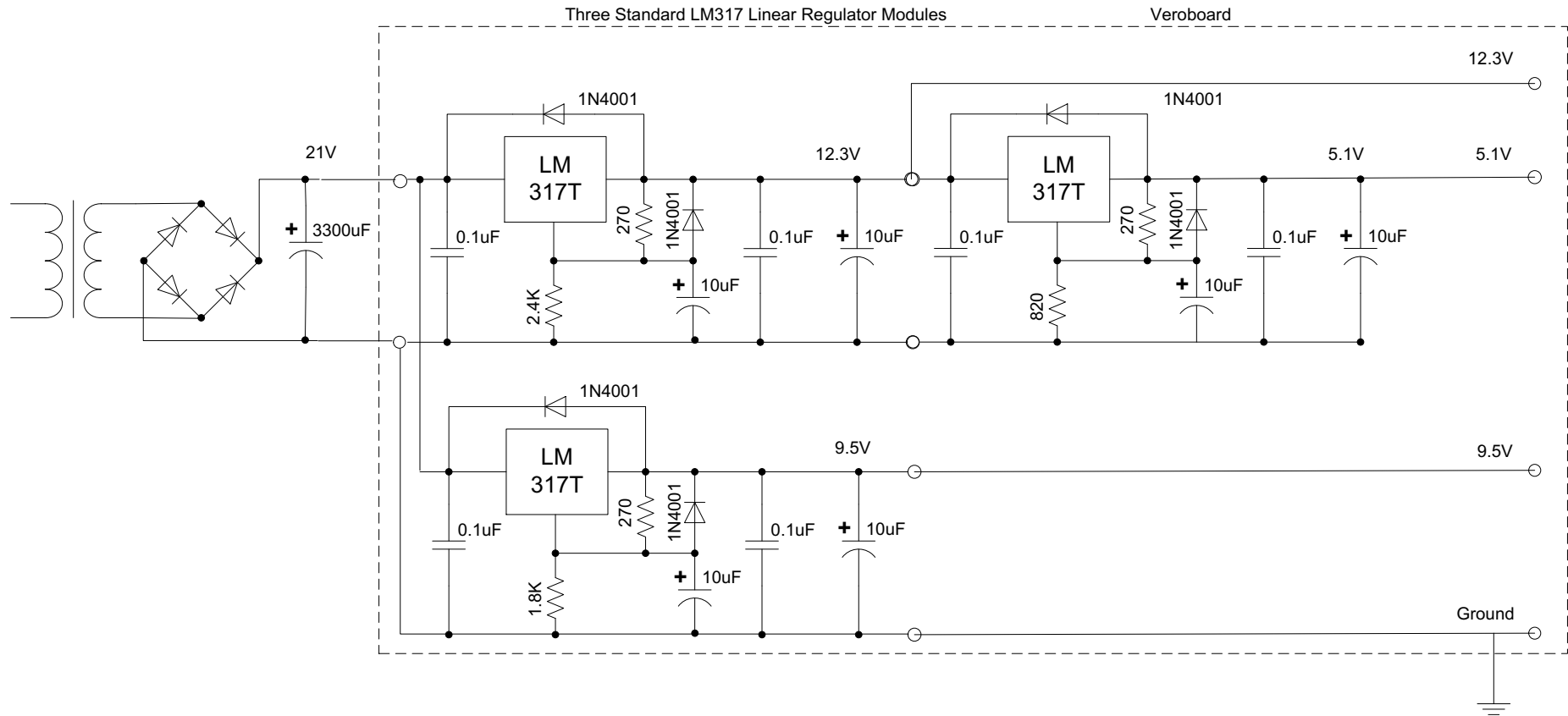
Drawing 11a Base Node SCADA Unit  
Control Arduino I/O details



Drawing 11b Base Node SCADA  
Supervisory Arduino I/O details



## Drawing 11c Base Node SCADA Unit Power Supply



## Part 2 Site SCADA Unit

### Site SCADA Unit Overview

The Site SCADA Unit has two main functions:

The Site SCADA Unit serves as the key interface and distribution point for all interconnections with other devices on site.

The unit contains the remote control and supervisory computers that communicate with the Node Station SCADA Unit.

The Site SCADA Unit has provision for an alternative system for communication with the Node Site Connection points are available by way of three DB 37 pin sockets: SKA, SKB, and SKC on the back of the unit.

### Remote Control

The Control Functions that are facilitated by the Site SCADA Unit include:

On- Off control of transceivers and Linear Amplifiers

Antenna Selection for each of the two Transceiver -Linear Combos

Directivity switching of up to 4 Four Square arrays

Excluded from this manual is the **Remote Rig** system that controls just the ICOM Transceiver functions of voice and data.

The Control Functions are listed in detail in the tables below:

#### Remote Site SCADA Unit Remote Controls:

SK1 Pin	Use	Command	Base Node Input Logic	Remote Site Output Logic	Description
	<b>Power Controls</b>				
1	Transceiver 1	TXCVR On	1=Open 0=Active	1= Off 0= ON	This turns the 24-12V DC Voltage buck from idle to full on.
2	Transceiver 1	TXCVR Off	1=Open 0=Active	1= Off 0= ON	This turns the 24-12V DC Voltage buck to idle.
3	Linear Amp 1	LIN 1 On	1=Open 0=Active	1= Off 0= ON	This turns the 24V DC to 230V AC Inverter to ON.
4	Linear Amp 1	LIN 1 Off	1=Open 0=Active	1= Off 0= ON	This turns the 24V DC to 230V AC Inverter OFF.
5	Transceiver 2	TXCVR On	1=Open 0=Active	1= Off 0= ON	This turns the 24-12V DC Voltage buck from idle to full on.
6	Transceiver 2	TXCVR Off	1=Open 0=Active	1= Off 0= ON	This turns the 24-12V DC Voltage buck to idle.



7	Linear Amp 2	LIN 2 On	1=Open 0=Active	1= Off 0= ON	This turns the 24V DC to 230V AC Inverter to ON.
8	Linear Amp 2	LIN 2 Off	1=Open 0=Active	1= Off 0= ON	This turns the 24V DC to 230V AC Inverter OFF.
	<b>Antenna Selector 1</b>				
9	Position A1	S1 pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
10	Position A2	S1 pos 2	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
11	Position A3	S1 pos 3	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
12	Position A4	S1 pos 4	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
13	Position A5	S1 pos 5	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
14	Position A6	S1 pos 6	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5 <u>50 Ohm Load</u>

	<b>Antenna Selector 2</b>				
15	Position A1	S2 pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
16	Position A2	S2 pos 2	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
17	Position A3	S2 pos 3	1=Open 0=Active	01=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
18	Position A4	S2 pos 4	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
19	Position A5	S2 pos 5	1=Open 0=Active	01=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 5
20	Position A6	S2 pos 6	1=Open	1=Normal	"0" closes output

			0=Active	0= Select	relay.Switch press (pulse 100ms) Logic Interlocked with other 5 <u>50 Ohm Load</u>
	<b>Directivity 4 Square Array 1</b>				
21	Direction NW (315°)	4S1 Pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 3 <u>NW Direction</u>
22	Direction NE (45°)	4S1 Pos 2	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>NE Direction</u>
23	Direction SE (135°)	4S1 Pos 3	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>SE Direction</u>
24	Direction SW (225°)	4S1 Pos 4	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>SW Direction</u>
	<b>Directivity 4 Square Array 2</b>				
25	Direction NW (315°)	4S2 Pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 3 <u>315°T</u>
26	Direction NE (45°)	4S2 Pos 2	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>45°T</u>
27	Direction SE (135°)	4S2 Pos 3	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>135°T</u>
28	Direction SW (225°)	4S2 Pos 4	1=Open 0=Active	1=Normal 0= Select	Ditton above <u>225°T</u>
	<b>Directivity 4 Square Array 3</b>				
29	Direction NW (315°)	4S2 Pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 3 <u>315°T</u>
30	Direction NE (45°)	4S2 Pos 2	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>45°T</u>
31	Direction SE (135°)	4S2 Pos 3	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>135°T</u>
32	Direction SW (225°)	4S2 Pos 4	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>225°T</u>
	<b>Directivity 4 Square Array 4</b>				
33	Direction NW (315°)	4S2 Pos 1	1=Open 0=Active	1=Normal 0= Select	"0" closes output relay.Switch press (pulse 100ms) Logic Interlocked with other 3

					<u>315°T</u>
34	Direction NE (45°)	4S2 Pos 2	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>45°T</u>
35	Direction SE (135°)	4S2 Pos 3	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>135°T</u>
36	Direction SW (225°)	4S2 Pos 4	1=Open 0=Active	1=Normal 0= Select	Ditto above <u>225°T</u>
37	Common Earth				Common for all 36 pins above

#### Notes:

- The numbering on the left of this table is a means of numbering the digital control functions. They are also the pin numbers for SK1 on the Remote Site SCADA box.
- Earlier thinking (and the hardware wiring of the 4 Square Controllers) had hand-shaking indications between these devices. This has been dropped.
- There is no PTT (TX On) command carried by this remote control system. The remote rig system carries this command.
- PTT (TX ON) command is taken from the ICOM transceiver at the remote site and used for 3 other functions:
  4. Activate the Linear Amplifier associated with that transceiver
  5. Inhibit any switching in the Antenna Selector while transmitting
  6. Inhibit any switching of 4 square array directivity while transmitting.
- Details of the PTT and interlock operation are described in the Manual for **ICOM and Linear interface Unit**

## Supervisory

The Supervisory Functions that are facilitated by the Site SCADA Unit include:

Off-On Status of the transceivers and Linear amplifiers

Indication of which Antenna is selected to each Transceiver – Linear combo.

Indication of the direction selected for each 4 Square Array

Excluded from this manual is the **Remote Rig** system that surveils the ICOM Transceiver.

The Supervisory Functions are listed in detail in the tables below

#### Supervisory Digital Indications:

SK2 Pin	Use	Data Point	Remote Site Input Logic	Base Node Output logic	Description
	<b>Power Indications</b>				
1	Transceiver 1	TXCVR On	1=Open 0=Active	1 = OFF 0 = ON	Indicates 12V is supplied to the transceiver and associated units
2	Transceiver 1	TXCVR Off	1=Open 0=Active	1 = OFF 0 = ON	Indicates 12V is <u>not</u> available for the transceiver and associated units

3	Linear Amp 1	LIN 1 On	1=Open 0=Active	1 = OFF 0 = ON	Indicates 24V DC is On to the 24V to 230Vac inverter 1.
4	Linear Amp 1	LIN 1 Off	1=Open 0=Active	1 = OFF 0 = ON	Indicates 24V DC is Off to the 24V to 230Vac inverter 1.
5	Transceiver 2	TXCVR On	1=Open 0=Active	1 = OFF 0 = ON	Indicates 12V available for the transceiver and associated units
6	Transceiver 2	TXCVR Off	1=Open 0=Active	1 = OFF 0 = ON	Indicates 12V is <u>not</u> available for the transceiver and associated units
7	Linear Amp 2	LIN 2 On	1=Open 0=Active	1 = OFF 0 = ON	Indicates 24V DC is On to the 24V to 230Vac inverter 2.
8	Linear Amp 2	LIN 2 Off	1=Open 0=Active	1 = OFF 0 = ON	Indicates 24V DC is Off to the 24V to 230Vac inverter 2.
	<b>Antenna Switch 1</b>				
9		S1 pos 1	1=Open 0=Active	1 = OFF 0=selected	"0" = Green LED lit. Antenna Name Selected
10		S1 pos 2	1=Open 0=Active	1 = OFF 0=selected	"0" = Green LED lit. Antenna Name Selected
11		S1 pos 3	1=Open 0=Active	1 = OFF 0=selected	"0" = Green LED lit. Antenna Name Selected
12		S1 pos 4	1=Open 0=Active	1 = OFF 0=selected	"0" = Green LED lit. Antenna Name Selected
13		S1 pos 5	1=Open 0=Active	1 = OFF 0=selected	"0" = Green LED lit. Antenna Name Selected
14		S1 pos 6	1=Open 0=Active	1 =Normal 0= Select	50 Ohm load Selected
	<b>Antenna Switch 2</b>				
15		S2 pos 1	1=Open 0=Active	1 = OFF 0=selected	"0" = Green LED lit. Antenna Name Selected
16		S2 pos 2	1=Open 0=Active	1 = OFF 0=selected	"0" = Green LED lit. Antenna Name Selected
17		S2 pos 3	1=Open 0=Active	1 = OFF 0=selected	"0" = Green LED lit. Antenna Name Selected
18		S2 pos 4	1=Open 0=Active	1 = OFF 0=selected	"0" = Green LED lit. Antenna Name Selected
19		S2 pos 5	1=Open 0=Active	1 = OFF 0=selected	"0" = Green LED lit. Antenna Name Selected
20		S2 pos 6	1=Open 0=Active	1 = OFF 0=selected	50 Ohm load Selected
	<b>4 Square No 1 (Direction)</b>				
21		NW Selected	1=Open 0=Active	0 = OFF 1=selected	Indicates remote station selection Green LED
22		NE Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection Green LED
23		SE Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection Green LED
24		SW Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection Green LED
	<b>4 Square No 2 (Direction)</b>				
25		315°T Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection Green LED
26		46°T	1=Open	1 = OFF	Indicates remote station selection

		Selected	0=Active	0=selected	Green LED
27		135°T Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection Green LED
28		225°T Selected	1=Open 0=Active	1 = OFF 0=selected	Indicates remote station selection Green LED
	<b>4 Square No 3 Direction</b>				
29		Reserved			
30		Reserved			
31		Reserved			
32		Reserved			
	<b>4 Square No 4 Direction</b>				
33		Reserved			
34		Reserved			
35		Reserved			
36		Reserved			

- The numbering on the left of this table is a means of numbering the digital control functions. They are also the pin numbers for SK2 on the Remote Site SCADA box.

#### Analogue Supervisory Indications

SK3 Pin	Use	Analogue Indication	Data Exchange	Description
1	4 Square 1	Balance Load Power	8 bit	Power in dummy load 10 – 100 Watts
2	4 Square 2	Balance Load Power	8 bit	Power in dummy load 10 – 100 Watts
3	4 Square 3	Reserved	8 bit	
4	4 Square 4	Reserved	8 bit	
5	Station Battery 24V	Voltage	8 bit	Volts
6		Current	8 bit	Amps
7	SWR Monitor 1	Forward	8 bit	Forward power indication
8		Reflected	8 bit	Reflected power indication
9	SWR Monitor 2	Forward	8 bit	Forward power indication
10		Reflected	8 bit	Reflected power indication
11	Solar Panel 1	Current	8 bit	
12	Solar Panel 2	Current	8 bit	
13	Building Heat	Temperature	8 bit	Building Temperature
14	Spare			

#### Remote Site SCADA Unit Construction and Wiring

As with the Node Site Unit, the fundamental design rule that has been applied is: All digital inputs and digital outputs of the Arduino devices are to be electrically isolated from any peripheral devices that get connected them.

The isolation is provided by opto couplers and relays ensures a more reliable and stable operation under conditions of high RF that might happen at the remote site.

Ready-made relay boards are used for all Arduino outputs and PC817 devices on custom boards for all Arduino inputs. The Arduino outputs use 5V relays boards that are available in combinations of 2, 4

or 8 relays per board. While these are a bit bulky they are a low cost way of achieving excellent isolation.

A different approach is used for inputs to the Arduino: Custom boards with 36 opto isolators using small devices such as the PC817 as these are more compact compared to the ready-made 5V relay boards.

### How the Remote Site SCADA Unit works

Remote controls: These are outputs from the “Control Arduino” and are wired to the various sockets on the unit:

Name	Type	Control Pins
Off/On Controls	DB15	1, 2, 3, 4, 5, 6, 7, 8 & common, 12V=15
Antenna Selector 1	DB15	1, 2, 3, 4, 5, 6, & common 7, 12V=15
Antenna Selector 2	DB15	1, 2, 3, 4, 5, 6, & common 7, 12V=15
4 Square 1	DB25	1, 2, 3, 4 & common 5
4 Square 2	DB25	1, 2, 3, 4 & common 5
4 Square 3	DB25	1, 2, 3, 4 & common 5
4 Square 4	DB25	1, 2, 3, 4 & common 5

In addition to this array of sockets for connection to devices on site, every relay switched output of the Control Arduino is also wired to SK1 on the unit.

Supervisory Indications: The digital inputs to the remote site SCADA Unit are via the sockets:

Name	Type	Supervisory input Pins
Off/On LED Indicators	DB15	1, 2, 3, 4, 5, 6, 7, 8 & common 15
Antenna Selector 1	DB15	9, 10, 11, 12, 13, 14 & common 8
Antenna Selector 2	DB15	9, 10, 11, 12, 13, 14 & common 8
4 Square 1	DB25	14, 15, 16, 17 & common 18, +12V =20
4 Square 2	DB25	14, 15, 16, 17 & common 18, , +12V =20
4 Square 3	DB25	14, 15, 16, 17 & common 18, , +12V =20
4 Square 4	DB25	14, 15, 16, 17 & common 18, , +12V =20

These inputs are connected to the Supervisory Arduino via 36 opto-couplers on a custom vero board. They are also available on SK2 of the unit. (also labeled “Indications”)

Powering the relay boards in the Remote Site SCADA Unit:

- All relay boards that control items on the site and are driven from the Arduino outputs, derive their power from the internal 5V supply of the Unit to prevent too much loading on the Arduino.
- All supervisory inputs to the Arduino from the Custom opto-isolator boards are powered from the Arduino 5V supply that it is inputting.

### Analogue Inputs wiring

Analogue Indications: These inputs are on the various sockets of the Site SCADA Unit:

Name	Type	Supervisory input Pins
Site Indicators	DB15	Not yet defined
4 Square 1 (Balance load Power)	DB25	6 & common 25
4 Square 2 (Balance load Power)	DB25	6 & common 25
4 Square 3 (Balance load Power)	DB25	6 & common 25
4 Square 4 (Balance load Power)	DB25	6 & common 25

SWR 1	DIN 6pin	Not yet defined
SWR 2	DIN 6pin	Not yet defined

There are also parallel connections of these inputs on SK3

(Dealing with the earth arrangements for analogue sender units will need careful thought)

## **Block and circuit Diagrams**

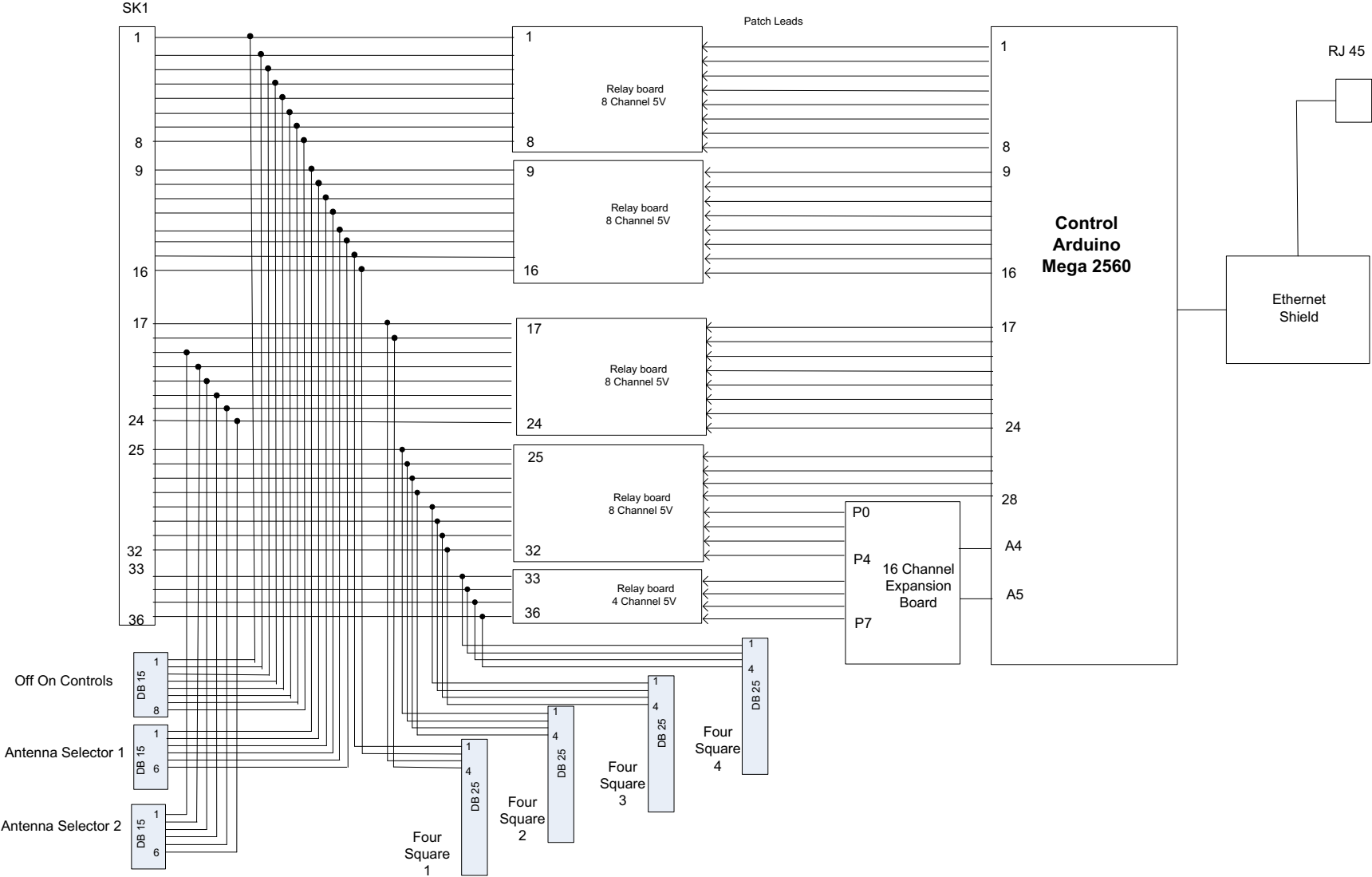
### **12a Remote Site SCADA Unit Control Arduino io Details**

### **12b Remote Site SCADA Unit Supervisory io Details**

### **12c Remote Site SCADA Unit Power Supply (including backup)**

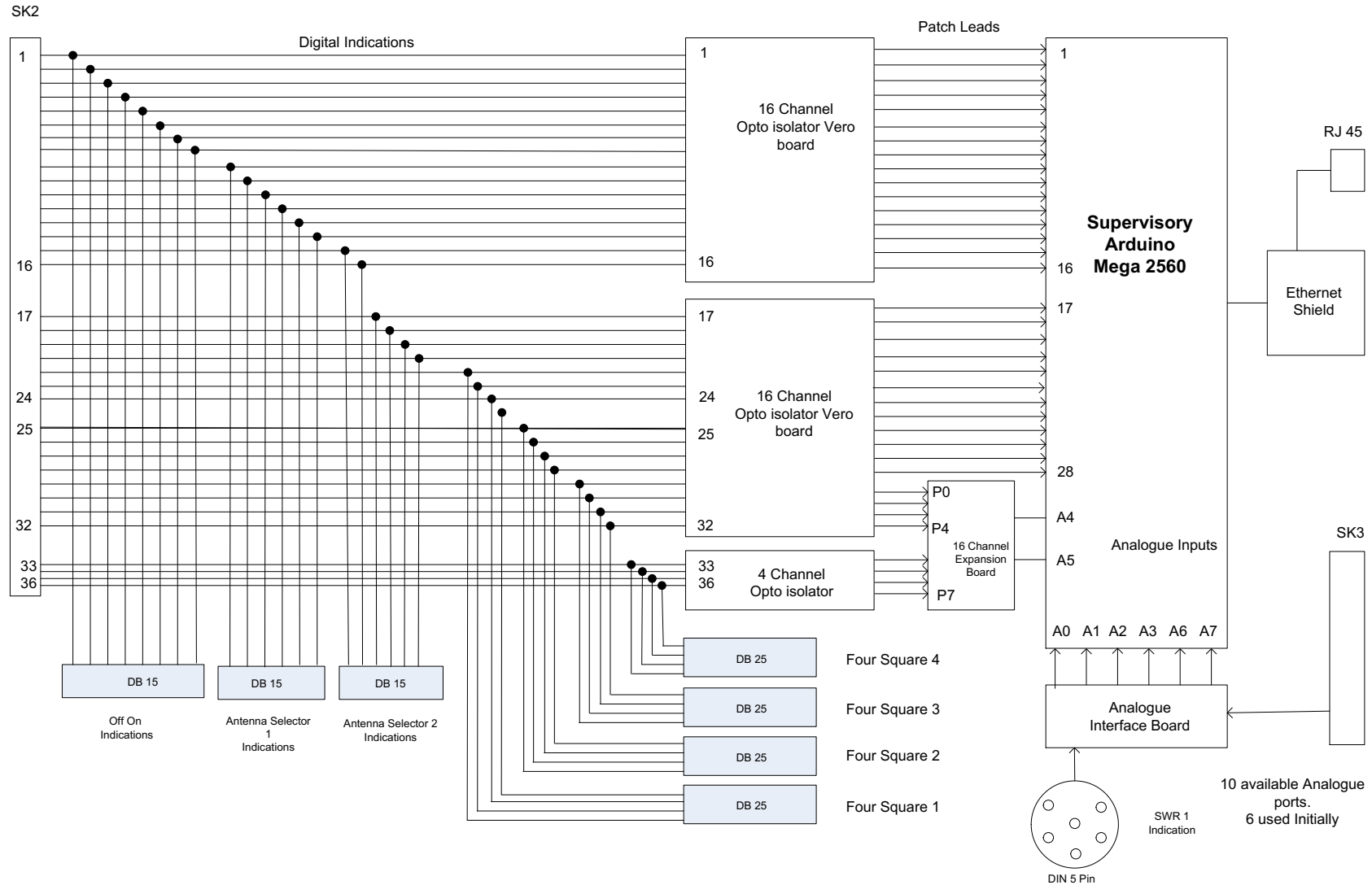
### **12d Remote Site SCADA Unit Connector Panel and cable pin-outs**

Drawing 12a Remote Site SCADA Unit  
Control Arduino I/O Details

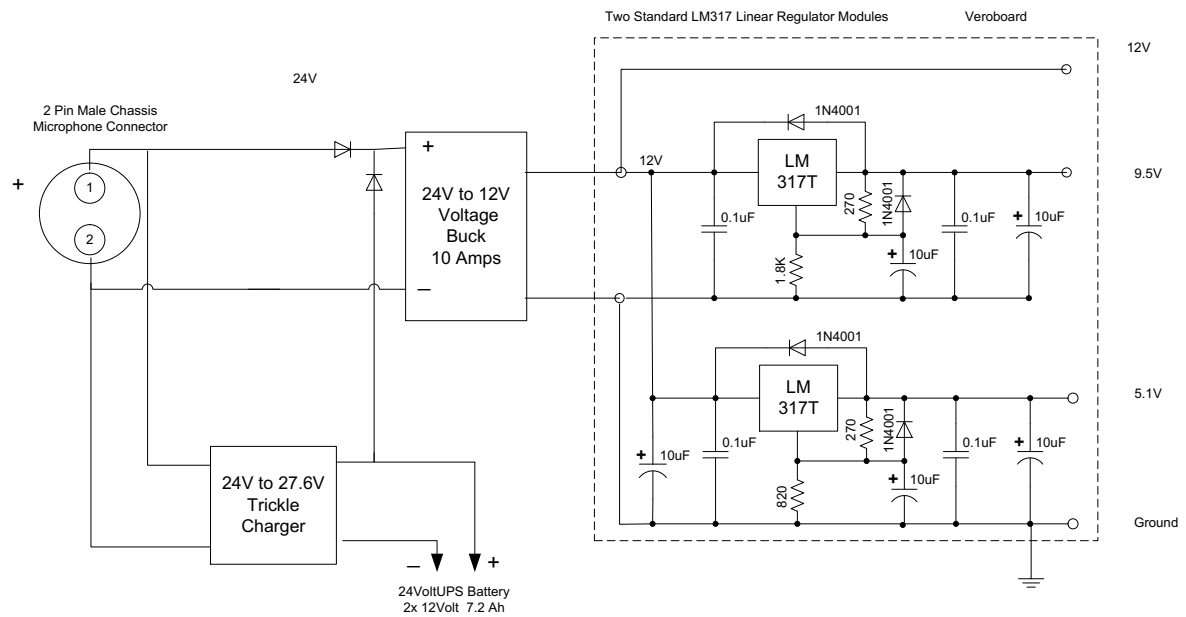




**Drawing 12b Remote Site SCADA Unit  
Supervisory Arduino I/O**



## Drawing 12c Remote Site SCADA Unit Power Supply



### Power Supply Description

The Site Scada Units primary supply is the Station 24Volt system. This is applied to a 24V to 12V buck to provide the 12Volts needed to operate several external devices including the Antenna Selector Units and Four square antenna array systems.

The primary input 24V is also applied to a trickle charger that maintains the separate UPS 24V supply batteries. 2x 12V 7.2ah Batteries in series.

The 24V UPS backed up supply is used to operate the OFF ON control modules external to the SCADA unit.

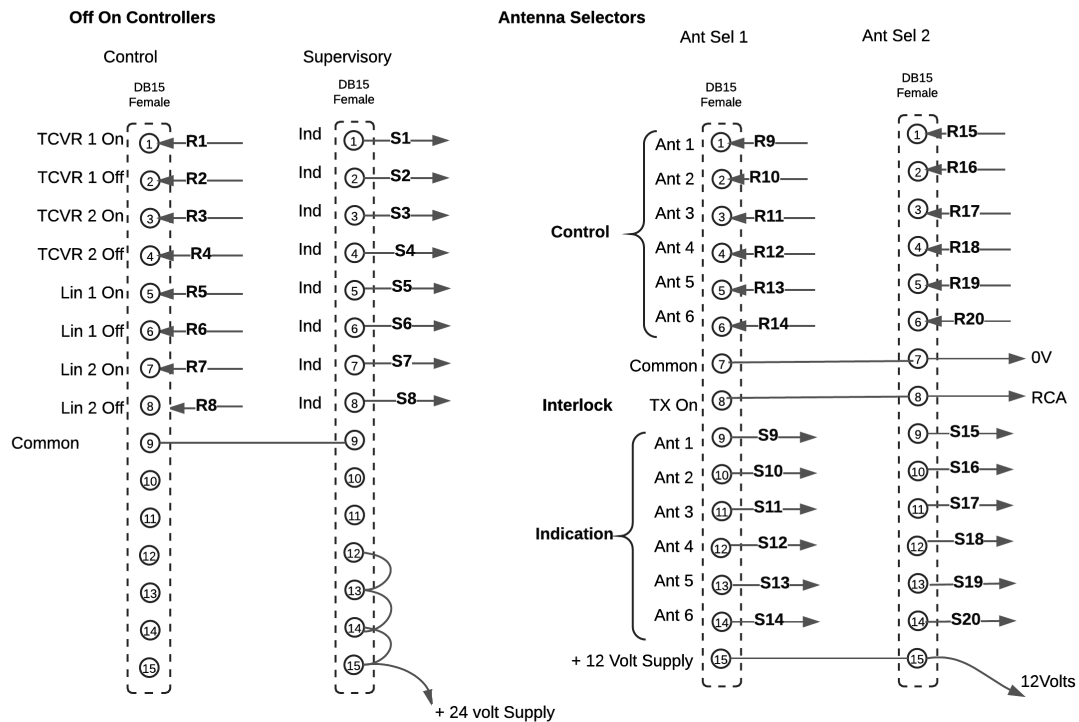
The 9.5V and 5.1V supplies provided by the LM317T regulators are used for the Arduino Computers and associated relays and optocouplers.

# Connector Panel and Cable Looms pin-outs

Bernard Robbins | March 1, 2017

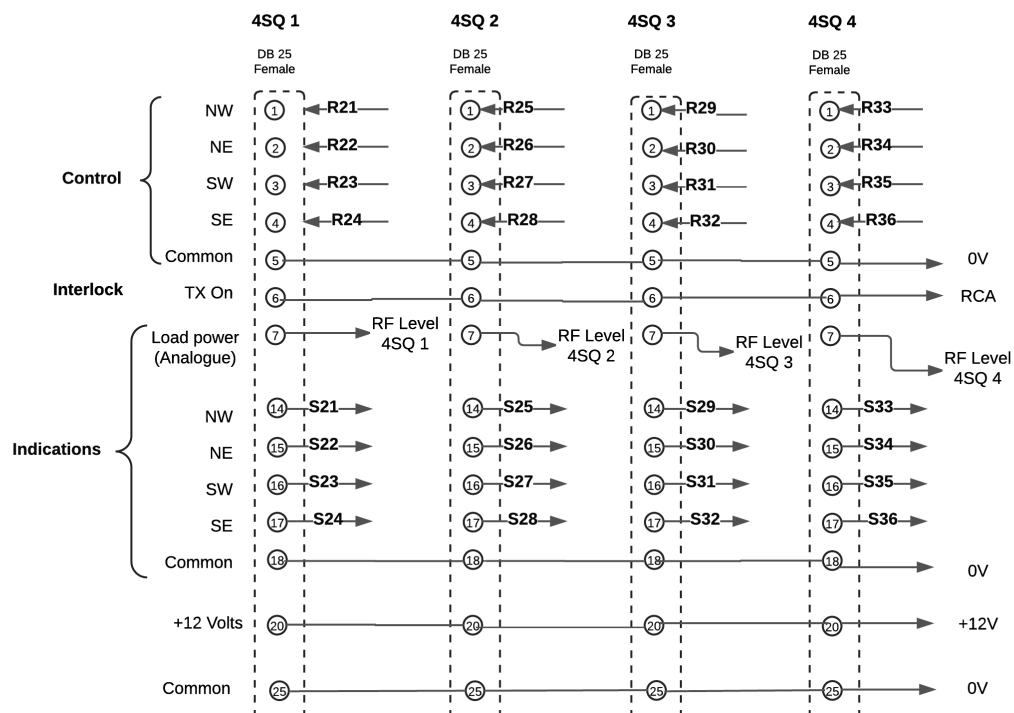
## SITE SCADA UNIT PANEL SOCKETS

R= Remote Control Relay  
S= supervisory Input opto couplers



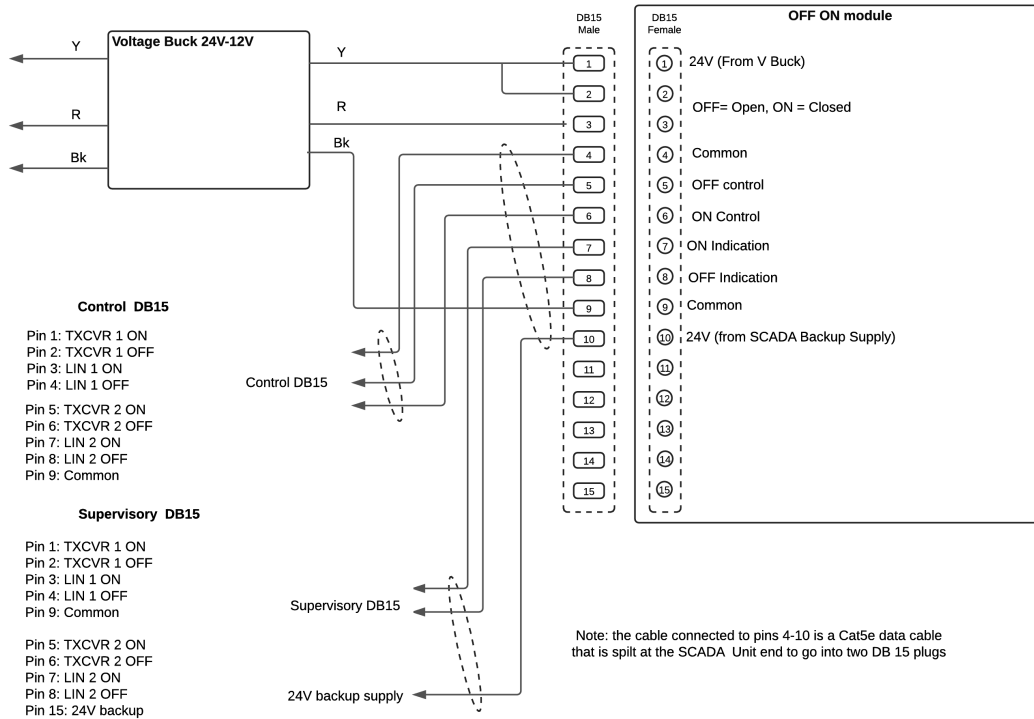
## Four Square Controllers

R= Remote Control Relay  
S= supervisory Input opto couplers



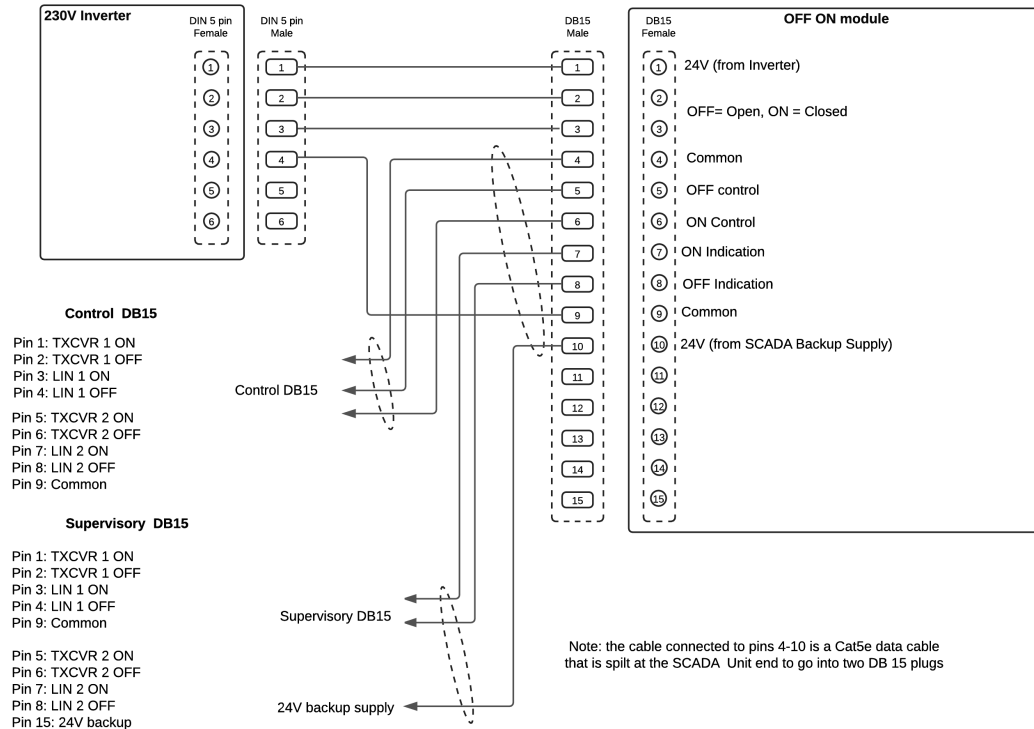
## CABLE LOOM V BUCK OFF ON MODULE

Bernard Robbins | March 1, 2017



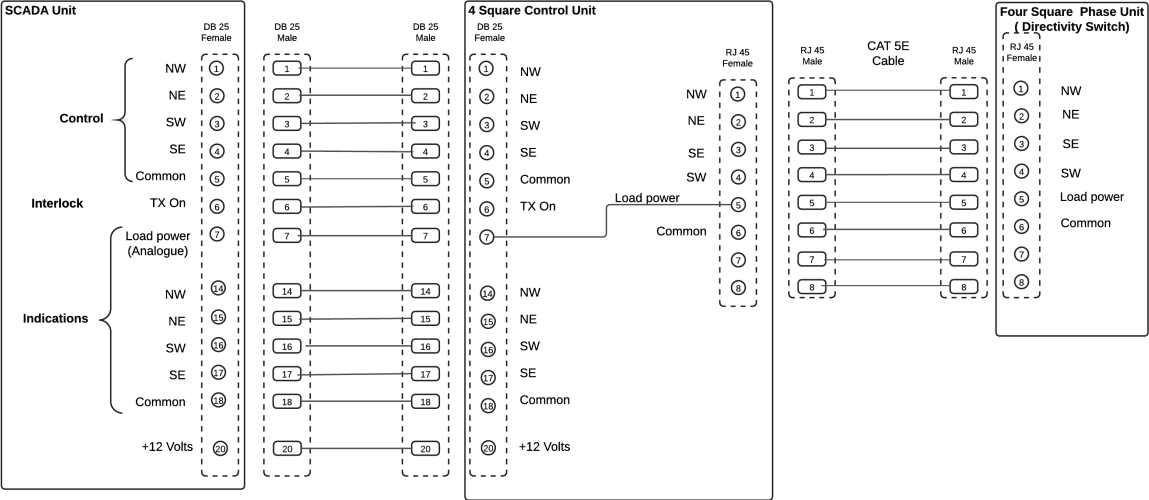
## CABLE LOOM INVERTER OFF ON 20170209

Bernard Robbins | March 1, 2017



CABLE LOOM PIN OUTS\_ FOURSQUARE CONTROLLER SYSTEM  
20170301

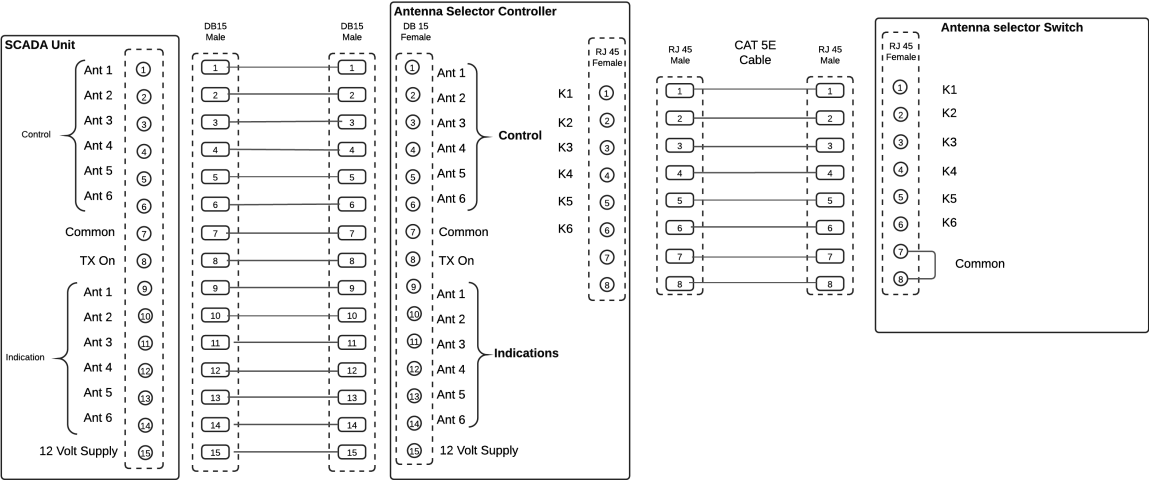
Bernard Robbins | March 1, 2017



**Note:** DB25 connectors were used on the original prototypes so have been continued here. Unused pins are not shown.

CABLE LOOM ANTENNA SELECTOR 20170309

Bernard Robbins | March 1, 2017



This BOM does not include the Arduino Computers of this Unit although the Relays and optocouplers are included..

Item	Description	Each	Cost
1	Rack Cabinet 3H plastic(Clearance price \$39.90)	1	39.90
2	Handles, and bracing aluminium		20.00
3	Power toggle Switch	1	3.90
4	5mm LEDs and clips (\$0.60ea)	2	1.20
5	24V Power connector (2 Pin Mic plug)	1	3.90
6	RCA Tx on connector	4	11.60
7	2.1mm Power connector	6	23.40
8	DB37 socket and plug with gold pins no shell.(5.90 +5.90)	3	35.40
9	DB25 sockets (2.50)	4	10.00
10	DB25 Plugs with gold pins and shells (4.50 + 3.90 ea)	2	16.80
11	DB15 socket (2.50)	5	12.50
12	DB15 plug and shell (2.50+2.90)	5	12.50
13	DIN 6 pin socket and plug (2.50+1.50)	2	8.00
14	8 channel 5V relay board (special price \$8.90ea)	3	26.70
15	4 Channel 5V relay board (special price \$6.90 ea)	4	27.60
16	10 pin header connectors (\$1.50ea)	3	4.50
17	6 pin header connectors (\$0.90 ea)	4	3.60
18	40 pin header terminal strips (\$1.50 ea)	2	3.00
19	Nuts Bolts and screws	50	5.00
20	Vero board	1	13.90
21	24V to 12 Volt converter	1	33.00
22	Rectifier and regulators: 9V and 5V supplies	1	10.00
23	Opto couplers and resistors (special price PC817 @ \$1.00ea)	36	36.00
24	Stranded Multicoloured hookup wire 50m.	N/C	
	<b>Total:</b>		<b>362.40</b>