

EVLA

Single Pole Four Throw (SP4T)

Switch Specification

A23010N0006

Version: A

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Change Record

Version	Date	Affected Section(s)	Change Request #	Reason/Initiation/Remarks
A	2011-08-19	All		Initial Draft

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1 Introduction

1.1 Purpose

This specification establishes the performance, design, manufacture, quality assurance, qualification, and acceptance requirements of the Single-Pole Four-Throw (SP4T) Switches. The SP4T Switches shall be referred to herein as the *switch* or *switches*.

1.2 Scope

This document covers all aspects of the switches. These switches are used four places in the array: LO switching (12-20 GHz, 3 each); high frequency front end switching (8-18 GHz, 2 each); low frequency front end switching (1-8 GHz, 2 each); and, converter switching (8-12, 4 each). The switches shall work interchangeably in any of the four switch locations. The reliability and switching cycle repeatability (phase and amplitude) are of the utmost importance in this application. The switches are a part of the Expanded Very Large Array (EVLA) (see www.nrao.edu).

2 Applicable Documents

2.1 Compliance Documents

The Vendor shall comply with the requirements of the following document of the exact issue shown to the extent specified herein. In the event of conflict between the document listed and the contents of this specification, this specification shall be the superseding document.

A23010N0007 EVLA SP4T Switch SOW (dated 2011-08-19, Rev A)

2.2 Reference Documents

The following document is listed as a reference document and shall be used for guidance only. This specification does not require compliance to the requirements of this reference document. Vendors should note instances where internal specifications and standards are substituted for this reference document.

[RD 01] ANSI/ASQC Z1.4-1993 Sampling Procedures and Tables for Inspection by Attributes

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3 Requirements

3.1 Item Definition

The switch is a microwave, latching type, SP4T Switch.

3.2 Specifications

The following subsections detail the RF, physical, interface, lifetime, environmental and safety specifications that the switches must satisfy.

3.2.1 DC Power Requirements

3.2.1.1 Input Voltage

The switch shall operate with an input voltage between 24 to 32 volts, DC. The input voltage shall have a maximum ripple of **TBD** mV.

3.2.1.2 Current Draw

The switch shall draw no more than 300 mA when operated with an input voltage in the range of paragraph 3.1.1.1 while switching.

3.2.1.2.1 Latching Mechanism

The switch latching can be accomplished either mechanically or magnetically.

3.2.1.3 Reverse Polarity Protection

The switch shall not be damaged by the application of reverse polarity voltage.

3.2.1.4 Transient Suppression Diodes

The switch shall have coil transient suppression diodes across all coils.

3.2.2 RF Performance

3.2.2.1 Characteristic Impedance

The nominal characteristic impedance of the switch shall be 50 ohms.

3.2.2.2 Frequency Range

The switch shall operate over the frequency range of 1 GHz to 20 GHz.

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3.2.2.3 RF Power Level

The RF power level applied at any switch port over the frequency range of paragraph 3.2.2.2 shall be +24 dBm, maximum.

3.2.2.4 Insertion Loss

The switch insertion loss shall be 0.30 dB maximum over the frequency range of paragraph 3.2.2.2.

3.2.2.5 Isolation

For any selected output (throw), the isolation between the common input (pole) and any unselected output (throw) shall be 80 dB @ 1-16 GHz and 75 dB minimum @ 16-20 GHz when the selected output is terminated in 50 ohms.

3.2.2.6 VSWR

The switch port VSWR shall be 1.20:1 maximum over the frequency range of paragraph 3.2.2.2 at any selected port when the output of that port is terminated in 50 ohms.

3.2.2.7 Switching Time

The switching time from 50% TTL input to 90% RF output shall be 20 ms maximum (15 ms, goal).

3.2.2.8 Amplitude and Phase Switching Repeatability

Amplitude and Phase stability is critically important in this application. For example, with the switch in position X at time T0 the switch position is changed to any other position and then back to position X at time T1. The phase measured at 18 GHz at time T1 shall be within $\pm 1^\circ$ of the value of the phase measured at time T0. The amplitude measured in dB(m) at time T1 at 20 GHz shall be within ± 0.1 dB of the amplitude measured at time T0. Both the phase and amplitude measurements assume the input signal amplitude and phase is constant between time T0 and T1. If the switch is switched back to position X at time Ts, T1 is defined to be Ts+5 seconds.

3.2.3 Monitor and Control Logic Requirements

3.2.3.1 Control Logic Requirements

The switch shall be controllable using TTL BCD logic. The truth table for switch position shall be as shown in the table in Table 1.

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Table 1: Truth table for BCD input and switch position output.

Input			Result
Logic 2	Logic 3	Logic 4	Switch Position
0	0	0	1
1	0	0	2
0	1	0	3
1	1	0	4
0	0	1	Vendor to specify behavior
1	0	1	
0	1	1	Reset (none)
1	1	1	All coils off

3.2.3.2 Monitor Requirements

The switch shall provide switch position indicators. The switch position indicator output pins shall be as specified in Table 2. The switch position indicator power input pin (common) is pulled to the voltage return line in the externally provided wire harness.

3.2.4 Lifetime Requirements

3.2.4.1 Reliability

The switches shall have a calculated MTBF of 300,000 hours per Telcordia SR332 for a Ground, Fixed, and Controlled environment. Vendor may propose alternate methods or provide previous results performed on a closely related switch/environment for approval by NRAO.

3.2.4.2 Failure Modes and Effects Analysis

The Vendor shall perform a Failure Modes and Effects Analysis (FMEA) and provide the results to the Buyer. This item shall be costed separately in the proposal.

3.2.4.3 Root Cause Analysis

For each switch failure within the warranty period, the Vendor shall perform a root cause failure analysis on the failed switch at the vendor's expense. The results of the failure analysis shall be provided to the Buyer. For switch failure beyond the warranty period, the Buyer *may* request a root cause analysis to be performed at the Buyer's expense.

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3.2.4.4 Maintainability

The Vendor shall design the switch such that there is no need for scheduled or preventative maintenance of the switch.

The Vendor shall identify repair turnaround times for failed switches.

3.2.4.5 Operating Life

The switch is used in a large-scale scientific radio astronomy application with an expected operational life of 30 years. Vendor should provide feedback in regards to this level of operating life requirement.

3.2.4.6 Age Sensitivity

The Vendor shall identify age-sensitive parts including criteria for age sensitivity and procedures for periodic servicing and/or life extension as applicable. Each switch shall include a list of age-sensitive items, date of manufacture, and schedule date for maintenance or replacement action.

3.2.5 Interface Definition

The switch shall comply with the following interface definitions. The Vendor shall submit an outline drawing for Buyer approval.

3.2.5.1 Physical Mounting Interface

The mounting provisions and mechanical interface for the switch shall be as suggested in Figure 1 and be shown in the outline drawing as specified in paragraph 3.2.5.

3.2.5.2 RF Signal Interface

The switch shall provide five coaxial connectors. The connectors shall be SMA Jack (female) oriented as suggested in Figure 1 and shall be shown in the outline drawing as specified in paragraph 3.2.5.

3.2.5.3 DC Power Interface

The switch will provide a circular connector such that the DC electrical connections (power, switch monitor and control) can be made to the switch without a solder operation. The switch circular connector shall interface properly with a PT06E-14-18S-SR connector. The connector key and DC and switch monitor and control pins shall be as defined in Table 2.

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Table 2: Circular connector pin definition

Pin	Function
A	+28V
B	N.C.
C	+28V Ret
D	N.C.
E	Logic 2
G	Logic 4
H	Logic 3
J	N.C.
K	Indicator Common
L	Ind Pos 1
M	Ind Pos 2
N	Ind Pos 3
P	Ind Pos 4
R	N.C.
S	N.C.
T	N.C.
U	N.C.

3.2.5.4 Hot Swap Capability

The switch shall not be damaged if the connector is removed and/or replaced with dc power and control pins 'hot'. The state of the control logic inputs can be any valid state. The sequencing of the application of the power and/or control logic power is random. (Vendor shall specifically address this requirement in the technical proposal.)

3.2.6 Physical Characteristics

The switch shall meet the following physical requirements.

3.2.6.1 Envelope

This switch shall have the dimensions as shown in Figure 1 or as shown in the outline drawing of paragraph 3.2.5.. The mounting holes locations are also shown in Figure 1. The vendor may propose alternate mounting holes locations for the four mounting holes. The mounting holes shall be 8-32 threaded through holes. The use of helical inserts is discouraged and shall not be used without the expressed approval of NRAO.

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3.2.7 Environmental Conditions

The switch shall meet the requirements of this specification during and after exposure to any combination of the following environments.

3.2.7.1 Random Vibration

The switch shall meet all performance requirements of this specification when exposed to random vibration levels of 3 G rms. Test condition is 3 axes, 20 minutes per axis. The acceleration spectral density (ASD) shall be as defined in the following table.

Table 3: Acceleration Spectral Density (ASD)

Amplitude	Frequency
0.006 g ² /Hz	20-1000 Hz
-6.02 dB/octave	1000-2000 Hz
0.0015 g ² /Hz (Reference)	2000 Hz

3.2.7.2 Acoustic Vibration

The switch shall meet all performance requirements of this specification when exposed to acoustic energy levels of 85 dBA. The acoustic noise peak is specified to be below 1 KHz and at least 50% minimum of the acoustic noise is below 1 KHz. (Refer to MIL-STD-810F, Method 515.5 Procedure I and Figure 515.5A-1.)

3.2.7.3 Temperature

3.2.7.3.1 Operating Temperature Range

The switch shall meet all performance requirements of this specification when operating over the temperature range of 10°C minimum to +40°C maximum.

3.2.7.3.2 Storage Temperature Range

The switch shall be capable of meeting all performance requirements of this specification after it has been stored for extended periods of time over the temperature range of -40°C minimum to +65° maximum.

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3.2.7.4 Altitude

The switch shall be capable of meeting all performance requirements when operating from sea level barometric pressure level through to the barometric pressure level of approximately 7500 feet.

3.2.7.5 Acceleration

The switch shall be capable of meeting all performance requirements after being exposed to a constant acceleration of 0.5 G around any axis.

3.2.7.6 Humidity

The switch shall be capable of meeting all performance requirements when the relative humidity (RH) is in the range of 1% to 95% (non-condensing). Humidity sealing is not required.

3.3 Design and Construction

The design process shall consider material, tolerancing, processes, methods, and techniques that will achieve the lowest cost consistent with acceptable performance.

3.3.1 Parts, Materials and Processes

The Vendor shall utilize a control system for parts, materials, and processes consistent with the requirements of ISO 9001.

3.3.1.1 Cleanliness

All internal and external surfaces shall be clean. The surfaces shall be free of oil and other contaminants. The interface surface of the SMA connector and the Teflon shall be free of dirt and metal particles. Dirty SMA connectors may result in a lot rejection of the switches.

3.3.2 Workmanship

The switch will be built using workmanship standards that meet or exceed MIL-STD-454 Requirement 9.

3.3.3 Interchangeability

All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable and replaceable. Switches shall be uniformly characterized to accommodate interchangeability without re-characterization or adjustment in the subsystem or system.

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3.3.4 Safety

3.3.4.1 Environmental, Health, and Disposal

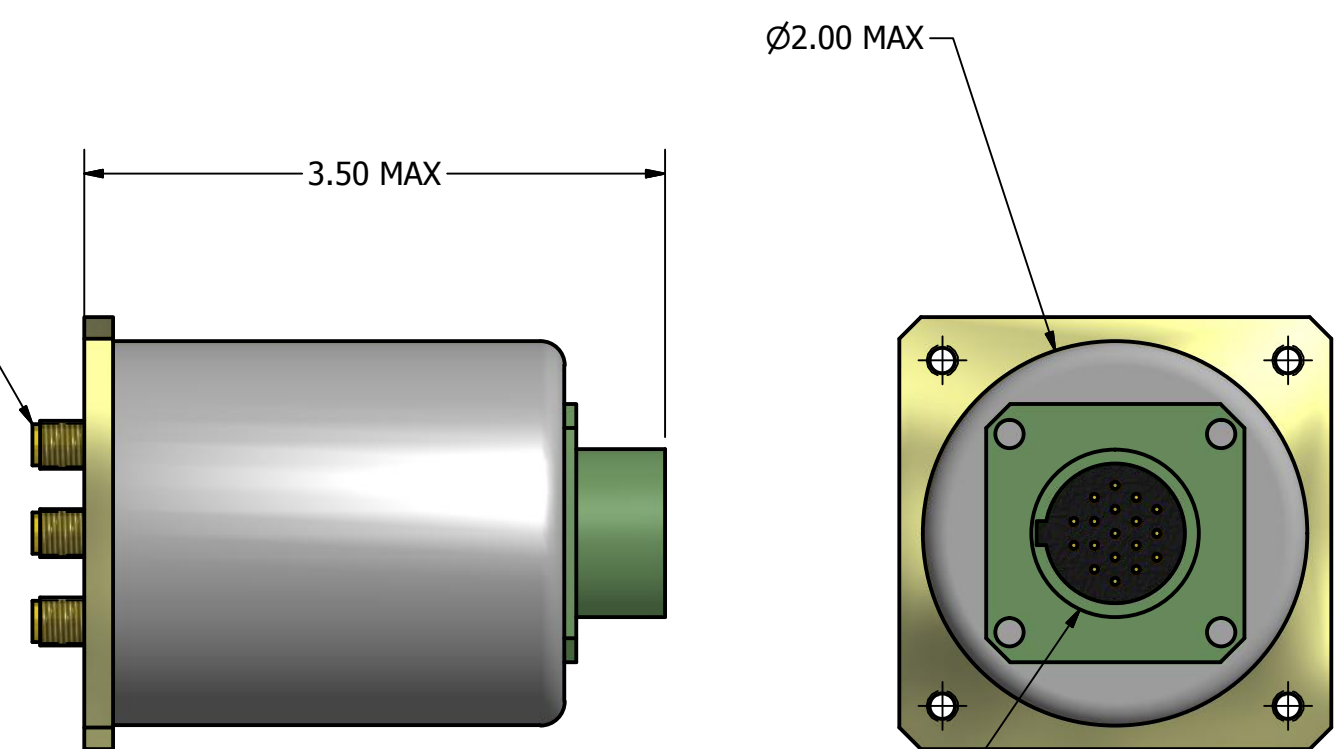
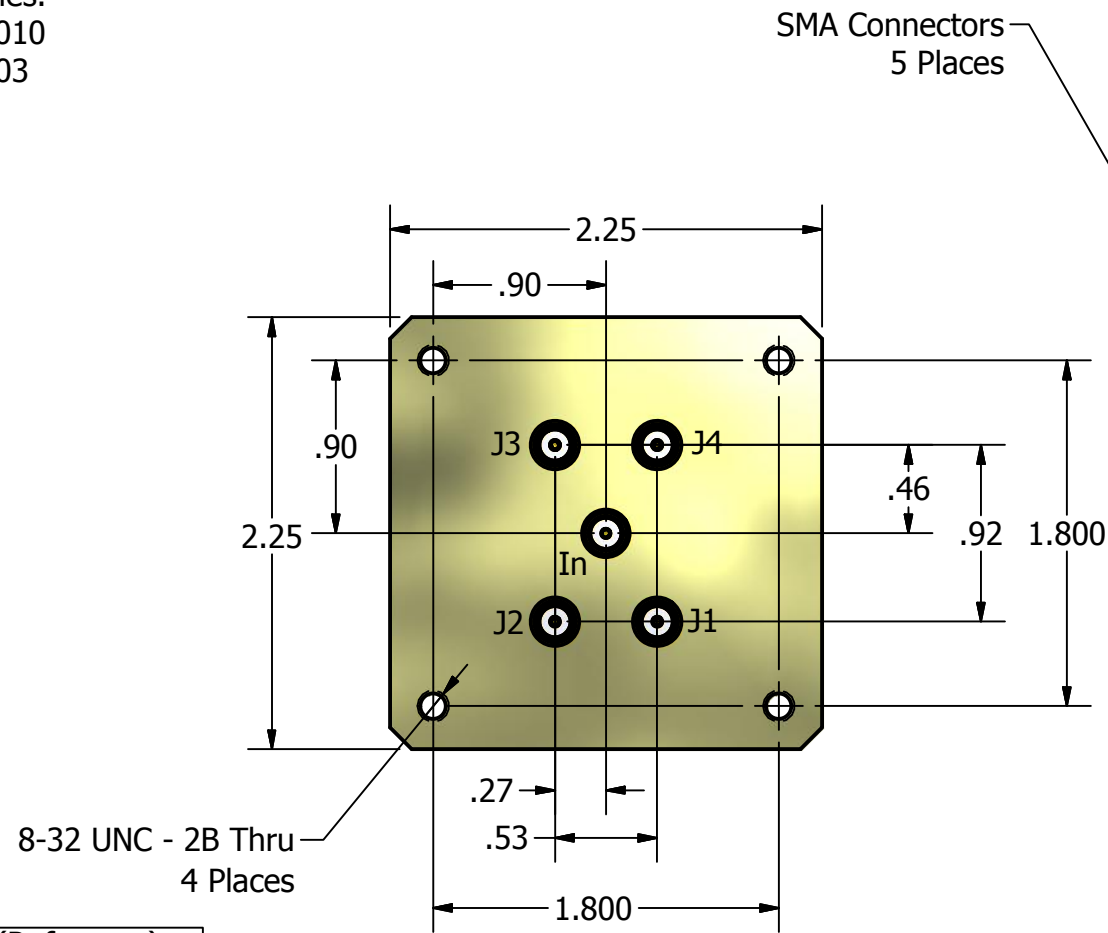
The Vendor shall comply with the safety, environmental, health and disposal requirements established in federal, state, and local rules and regulations.

3.3.4.2 Electrostatic Discharge Sensitive Devices

The switch shall include the proper protection of any ESD-sensitive electronics. The switch will have an ESD warning label if it is ESD-sensitive.

Notes:

1. Largest preferred size shown
2. Vendor free to propose alternate package options
3. All dimensions in inches.
4. Tolerances: .XXX ± .010
.XX ± .03



Connector mates to:
PT06E-14-18S-SR
Keyed as shown.
(see Table I and II)

Pin	Function
A	+28V
B	N.C.
C	+28V Ret
D	N.C.
E	Logic 2
G	Logic 4
H	Logic 3
J	N.C.
K	Ind common
L	Ind Pos 1
M	Ind Pos 2
N	Ind Pos 3
P	Ind Pos 4
R	N.C.
S	N.C.
T	N.C.
U	N.C.

Input	Logic 3	Logic 4	Result
Logic 2			Switch Position
0	0	0	J1
1	0	0	J2
0	1	0	J3
1	1	0	J4
0	0	1	Vendor to specify
1	0	1	behavior
0	1	1	Reset (none)
1	1	1	All coils off

DRAWN rscott	7/7/2011	TITLE Figure 1: EVLA Switch Outline Drawing (S1, S2, S3, S7, S8, S9)		
CHECKED				
QA				
MFG				
APPROVED		SIZE B	DWG NO A23010N0006	REV A
		SCALE	SHEET 1 OF 1	