Matrix Switch Box

VAC Longs Peak Project (Product 10-700-061-A) Product Overview/Spec's (Rev E)

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Two Year Limited Warranty

All Video Accessory Corporation (VAC) products have a full two year limited warranty. Exclusion to the warranty include but are not limited to damage to external components, power LED failure where the product continues to functions, electrical damage due to lightning or ESD, and minor cosmetic imperfections in the epoxy that do not affect the unit's performance. The warranty shall be void if any alteration or repair of the VAC product is attempted by anyone not authorized by VAC. This warranty is expressly in lieu of all other warranties expressed or implied, including warranties of merchantability and fitness for use, and of all other obligation or liabilities on the part of VAC, and it neither assumes nor authorizes any other person to assume for it any liability in connection with the sale of this product. This warranty shall not apply to the product or any part thereof subjected to accident, negligence, alteration, abuse or misuse. No warranty whatsoever is made with respect to accessories or parts supplied by anyone other than VAC, and this warranty shall extend only to the original purchaser of the product. The warranty provided in this article is exclusive and in lieu of, and buyer hereby waives, all other remedies, express or implied, arising by law or otherwise, including consequential damages, where or not occasioned by negligence of VAC. This warranty shall not be extended, altered or varied except by written instrument signed by VAC and buyer, and shall only apply within the boundaries of the continental United States. Liability of VAC is limited repair or replacement at the option of VAC. Warranty work is to be sent to VAC. Freight charges will be the responsibility of the purchaser.

Rev. 01-01-2018

Revision history:

Rev A	Feb. 29, 2008	Original document
Rev B (Proto)	March 4, 2008	Changed MMPV selection to BCD Changed power input voltage range Changed camera +12 VDC supplies
Rev C (Production)	July 4, 2008	Added software function descriptions Added text-on-screen function Added maintenance box details for maintenance support Added color bar generator for maintenance support Added video/sync detection
Rev D (Post 7/22 design review)	July 24, 2008	Removed JLTV/MMPV references Removed VGA paths Added 1x4 DA function to comp video outputs Changed pin-out tables Changed connector text on box to only 'J' numbers Changed input voltage to 18-32 VDC Changed +12 VDC camera supplies to 400ma steady state, 1.5A max for 1 min. Changed temp spec > Storage -40C to +70C Operating -40C to +60C Changed video matrix switch to 15 X 4 Changed selection bit table Added power control for power-up Added details on location/size of label Added details on firmware operation Added details on camera direction icons Added direction icon table
Rev E (Production)	Aug. 8, 2008	Added power to J7 and J10. Modified text-on-screen array format

1.0 Specification Overview

This specification defines the final configuration for the production version of the 10-700-061-A Video Matrix Switch unit. The initial production run is scheduled to start Sept., 2008.

2.0 Configuration

The 10-700-061-A consists of a 15 X 4 (14 cameras and 1 color bar generator) video matrix switch, text-on-screen insertion, configuration/maintenance port, and power system. The operating mode of the switch can be changed via HyperTerminal using a laptop connected to the USB Maintenance port. Configuration tables can be loaded so the unit can function in several predefined modes by selecting the desired configuration table
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3.0 Overview

Figure 1 shows an overall high level block diagram of the Matrix Switch box. The box has a 15 X 4 composite video matrix switch. The LCD ports have four control/selection bits to permit the user to select which composite video input is routed to the LCD port composite outputs. The selection bits are scanned by the uP so the operation of the selection bits can be modified via code. A color bar generator can be routed to any of the composite outputs for maintenance functions. If an input is selected that does not have valid video connected to it the text-on-screen function will cause the output to display “NO SIGNAL”.

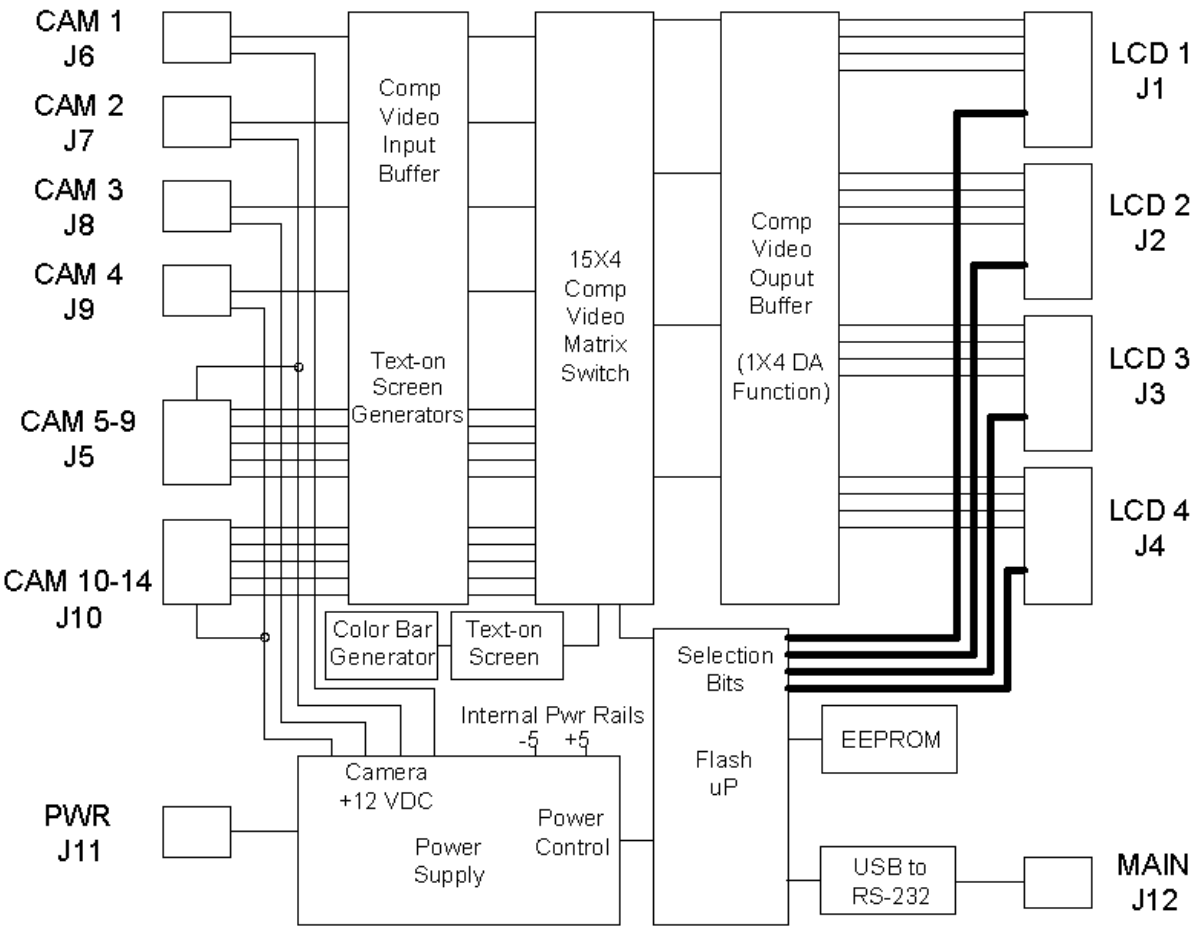


Figure 1 – Matrix Switch Box Block Diagram

4.0 Connectors

The following table shows the connector type and pin-out for each mode.

J1 - J4 DISPLAY INTERFACE

J1	TVP00RF-13-35PA-LC	Pins 10-407552-055
J2	TVP00RF-13-35PB-LC	
J3	TVP00RF-13-35PC-LC	
J4	TVP00RF-13-35PD-LC	

Pin	Direction	Electrical Characteristics	
1	Output	1 Vp-p	Composite video 1
2	Output		Comp video 1 RTN
3	Output	1 Vp-p	Composite video 2
4	Output		Comp video 2 RTN
5	Output	1 Vp-p	Composite video 3
6	Output		Com video 3 RTN
7	Output		Not Used
8	Output		Not Used
9	Output		Not Used
10	Output		Not Used
11	Output	1 Vp-p	Composite video 4
12	Output		Composite video 4 RTN
13	NC		Not Used
14	NC		Not Used
15	NC		Not Used
16	NC		Not Used
17	NC		Not Used
18	Input	TTL	Source Select 1
19	Input	TTL	Source Select 2
20	Input	TTL	Source Select 3
21	Input	TTL	Source Select 4
22	Input		Source Select Common

J5 & J10 (PC INTERFACES)

J5	TVP00RF-11-35-PA-LC	Pins 10-407552-055
J10	TVP00RF-11-35-PB-LC	

Pin	Direction	Electrical Characteristics		
1	Input	1 Vp-p		Composite video 1
2	Input			Composite video 1 RTN
3	Input	1 Vp-p		Composite video 2
4	Input			Composite video 2 RTN
5	Input	1 Vp-p		Composite video 3
6	Input			Composite video 3 RTN
7	Input	1 Vp-p		Composite video 4
8	Input			Composite video 4 RTN
9	Input	1 Vp-p		Composite video 5
10	Input			Composite video 5 RTN
11	NC			Reserved
12	NC			+12 VDC
13	NC			+12 VDC RTN

J6 thru J9 (CAMERA INTERFACES)

J6	TVP00RF-9-35SB-LC	10-497623-045
J7	TVP00RF-9-35SC-LC	
J8	TVP00RF-9-35SD-LC	
J9	TVP00RF-9-35SE-LC	

Pin	Direction	Electrical Characteristics		MMPV Signal Name
1	Input	1 Vp-p		Comp Vid In
2	Input			Comp Vid In RTN
3	NC			
4	Input			+12 VDC
5	NC			
6	Input			+12 VDC RTN

J11 (POWER INTERFACE)

J11 TVP00RF-9-98PA-LC Pins 10-497640-025

Pin	Direction	Electrical Characteristics	MMPV Signal Name
A	Input	DC Power	+28 VDC
B	Input	Power Rtn	+28 VDC RTN
C	Input	Gnd	Chassis GND

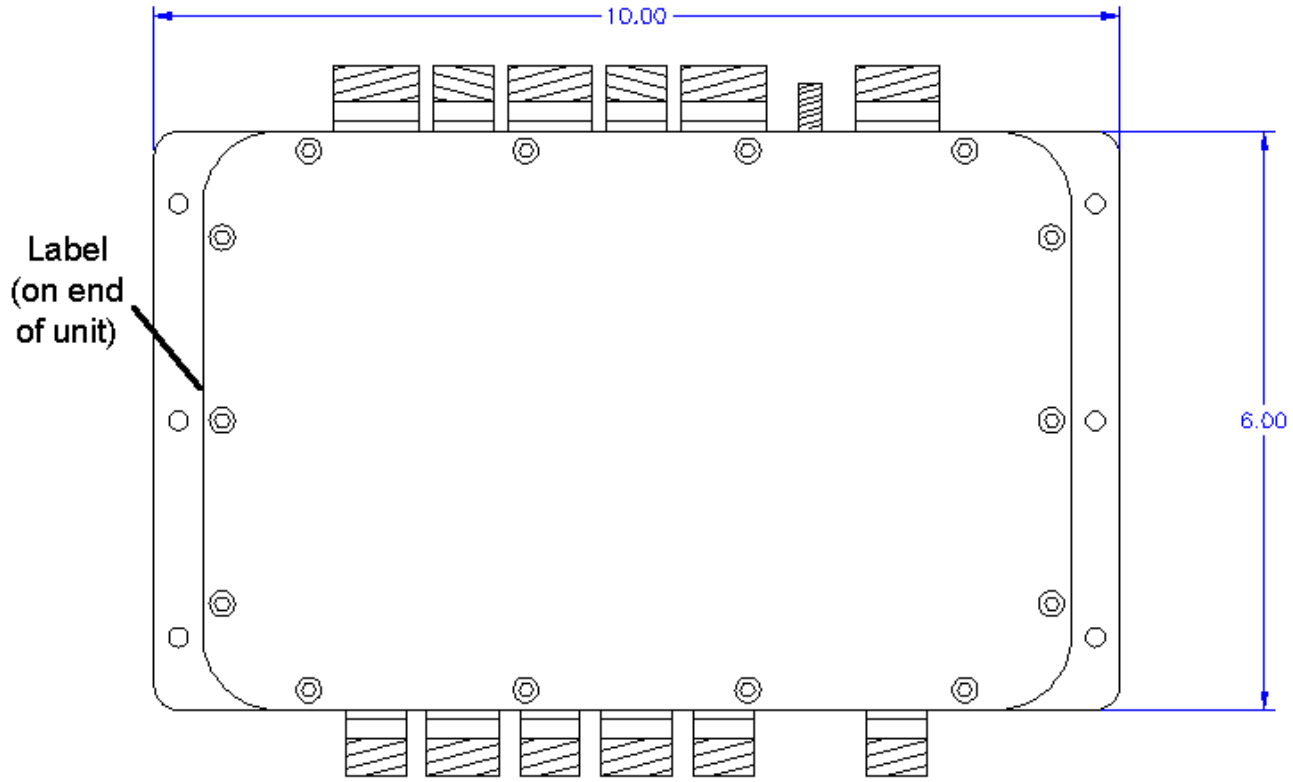
J12 (MAINTENANCE PORT INTERFACE)

J12 TVP00RF-9-35SA-LC Pins 10-497623-045

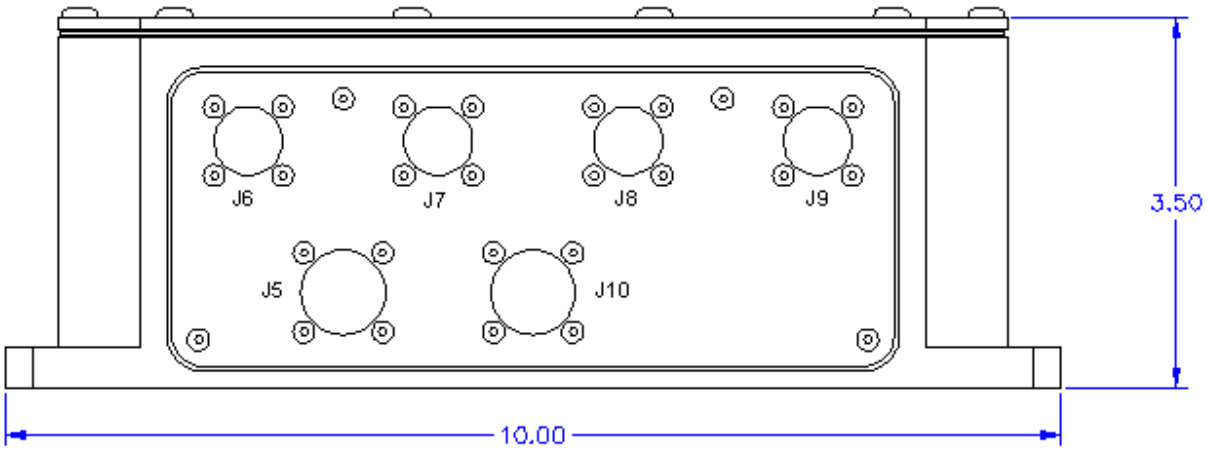
Pin	Direction	Electrical Characteristics	MMPV Signal Name
1	Input	+5 VDC	USB+5
2	In/Out	Logic	USBD+ or SCL
3	In/Out	Logic	USBD- or SDA
4	OUTPUT	Gnd	USBGND
5	OUTPUT	+5 VDC	+5 VDC power
6	INPUT	TTL	Main. Unit present

5.0 Package

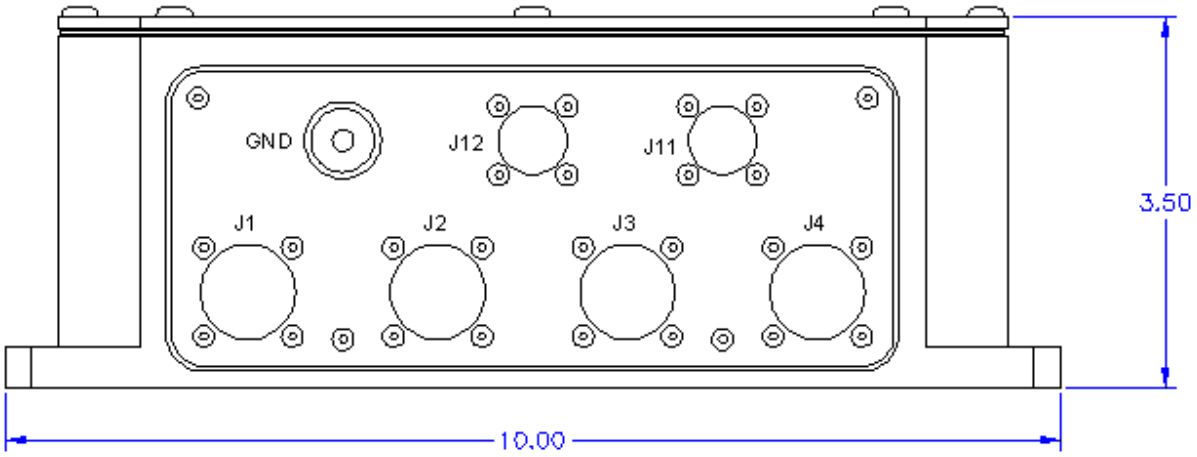
The following drawings show the matrix switch package. The box is machined out of a single block of 6061 aluminum so there are no seams that would reduce strength or provide EMI leakage paths. The lid is made of 0.125 thick 6061 aluminum plate. Both the box and lid are plated to MIL-C-5541E Class 1A (yellow chromate) and the outside surfaces powder coated black. An RF gasket is used between the lid and box. Each of the connectors has an RF gasket to provide both EMI protection and fluid protection.



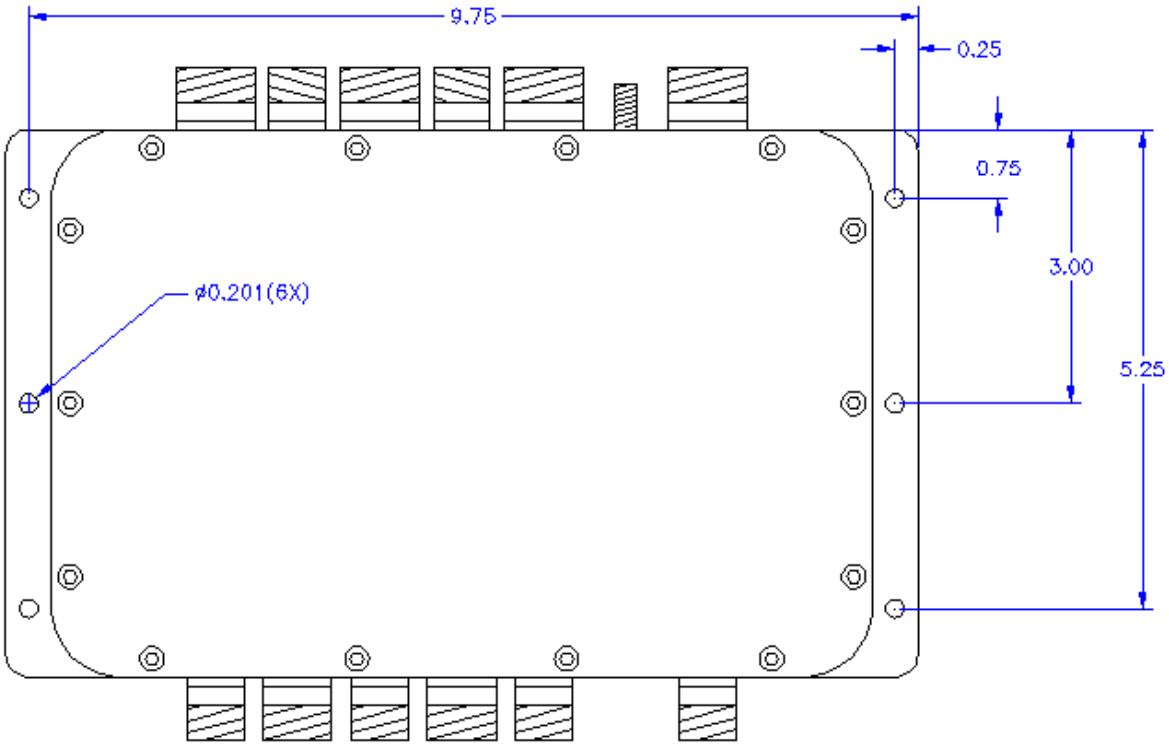
Top View



Input Side View (Front)



Output Side View (Back)



Mounting Holes

6.0 Input Buffers

Each of the 14 analog video inputs is terminated with 75 Ohms. A unity gain op amp (National LMH6702) is used to isolate the input from the internal circuits and provide current drive to connect the signal to the matrix switch IC.

7.0 Video Detect

Each video channel will have loss-of-video detection via the MAX7456 IC's. This IC will be connected to the video at the output of the input op amp buffer. With this approach the text-on-screen function can still generate a video output with a 'NO SIGNAL' text message for that input channel. The color bar generator will also have a loss-of-signal detector to support debug of the assembled unit.

8.0 Text-On-Screen Inserters

Each of the 14 camera inputs and the color bar generator have a MAX 7456 Text-on-Screen inserter. These inserters can be used to display text or camera direction icons. Each character is made up of 12 X 18 pixels. The screen overlay is made up of 12 rows by 24 characters. For the initial release of the code the user will be able to enter 20 characters of text on the bottom row, left justified. The following shows the factory default configuration text.

Input	Text
Camera 1 (J6, pins 1 & 2)	CAMERA 1
Camera 2 (J7, pins 1 & 2)	CAMERA 2
Camera 3 (J8, pins 1 & 2)	CAMERA 3
Camera 4 (J9, pins 1 & 2)	CAMERA 4
Camera 5 (J5, pins 1 & 2)	CAMERA 5
Camera 6 (J5, pins 3 & 4)	CAMERA 6
Camera 7 (J5, pins 5 & 6)	CAMERA 7
Camera 8 (J5, pins 7 & 8)	CAMERA 8
Camera 9 (J5, pins 9 & 10)	CAMERA 9
Camera 10 (J10, pins 1 & 2)	CAMERA 10
Camera 11 (J10, pins 3 & 4)	CAMERA 11
Camera 12 (J10, pins 5 & 6)	CAMERA 12
Camera 13 (J10, pins 7 & 8)	CAMERA 13
Camera 14 (J10, pins 9 & 10)	CAMERA 14
Internal Color Bars	INTERNAL COLOR BARS

Figure 2 shows the initial 16 camera direction icons. Four character positions will be used so a 24 X 24 pixel icon can be generated. The direction icon will be placed in the lower right corner of the display. The icon will be white on black background or black on a white background. The color can be selected via the configuration file. The factory default will be no icons for any of the video camera channels. A maximum of 36 icons can be defined and loaded into the Flash memory of the MAX7456's. Each icon can be defined as 24 X 36 pixels. The icons will be loaded at the factory during the final test process.

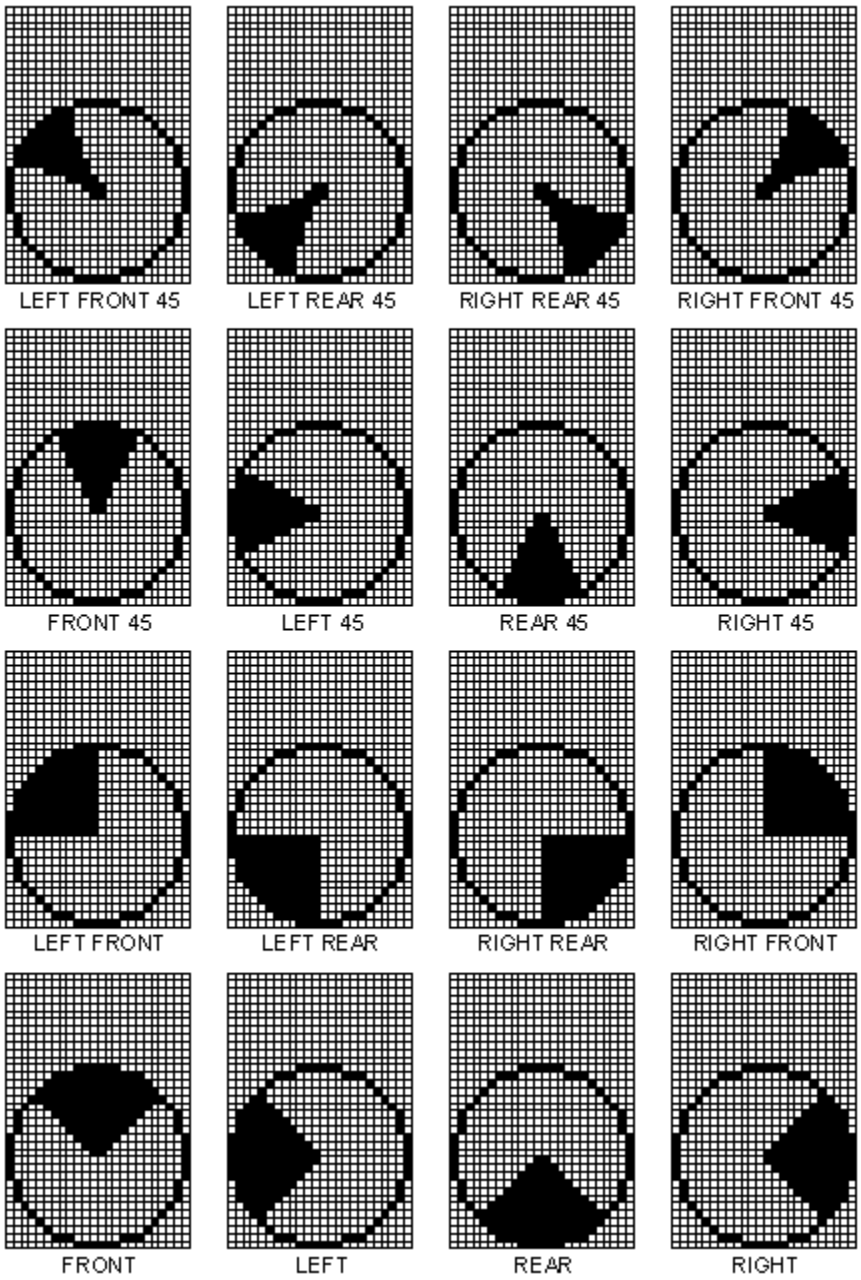


Figure 2 – Camera Direction Icons

9.0 Matrix Switch

An Analog Devices AD8106 16 X 5 is used to switch the analog video signals. Four of the outputs drive the four LCD display output connectors. The fifth output is connected to a loss-of-signal IC. This function provides a means to determine where a problem is located during debug of an assembled unit.

10.0 Output Buffers

Each analog video output is driven with an op amp (National LMH6702) set to a gain of 2 with a 75 Ohm series termination resistor. This provides the gain needed to drive a 75 Ohm load. All four video outputs on each of the display output connectors are connected (with their own 75 Ohm series resistor) to the single op amp. This provides a 1X4 DA function.

11.0 Input Selection

The operation of the four input selection bits is configured by the user. Any of the 15 inputs can be routed to any of the four outputs. The selection bits have a 2.2K Ohms pull-up resistor. The maximum voltage that can be applied to the selection bits is +5 VDC (TTL). Contact closure can be used to pull the selection bit to the ground reference. Each display's four selection bits can be set independently from the other three displays as to which camera is routed to the display (or color bars) for each of the 16 select bit combinations. The following shows the factory default mapping for the selection bits. All four displays are mapped with the same routing.

1=Open circuit
0=Bit connected to ground reference

Selection Bit s				**Selected Input**
3	**2**	**1**	**0**	
1	1	1	1	Camera 1 (J6, pins 1 & 2)
1	1	1	0	Camera 2 (J7, pins 1 & 2)
1	1	0	1	Camera 3 (J8, pins 1 & 2)
1	1	0	0	Camera 4 (J9, pins 1 & 2)
1	0	1	1	Camera 5 (J5, pins 1 & 2)
1	0	1	0	Camera 6 (J5, pins 3 & 4)
1	0	0	1	Camera 7 (J5, pins 5 & 6)
1	0	0	0	Camera 8 (J5, pins 7 & 8)
0	1	1	1	Camera 9 (J5, pins 9 & 10)
0	1	1	0	Camera 10 (J10, pins 1 & 2)
0	1	0	1	Camera 11 (J10, pins 3 & 4)
0	1	0	0	Camera 12 (J10, pins 5 & 6)

0	0	1	1	Camera 13 (J10, pins 7 & 8)
0	0	1	0	Camera 14 (J10, pins 9 & 10)
0	0	0	1	Color bars
0	0	0	0	Color bars

12.0 Environmental

Temperature: Storage -40C to +70C
Operating -40C to +60C

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Humidity: The target is 0 – 99%. The box is sealed for water and liquids. The connectors are the area that will have the least resistance to liquids.

EMI: The box is plated with a conductive coating and the lid uses a large surface area RF gasket.

Shock/Vib: The box itself should not be a problem being a single piece of aluminum. The PCB's are mounted with screws at the corners as well as at the center to reduce the distance for any given mounting location to another to under 3.5". As a backup plan we can fill the box with epoxy and ensure parts do no move and water does not get in.

13.0 Power Supply

The power supply is designed to run from 18-32 VDC. The supply is divided into several separate supplies. There are four +12 VDC supplies for the four camera inputs. Each of the camera supplies has a switcher supply to reduce the input voltage to +12.5 VDC, and an output linear regulator to set the voltage to +12.1 VDC and limit the output voltage ripple to +/- 50mv. The camera supplies are designed to supply 1.5 amps. A +5 VDC supply supports the uP and control logic. A +5/-5 VDC supply provides analog power for the Op Amps. Another +5 VDC supply is used to support the 15 text-on-screens. Eight layer PCBs are used with logic and analog ground planes to control noise.

Figure 3 shows a basic summary of the power supply.

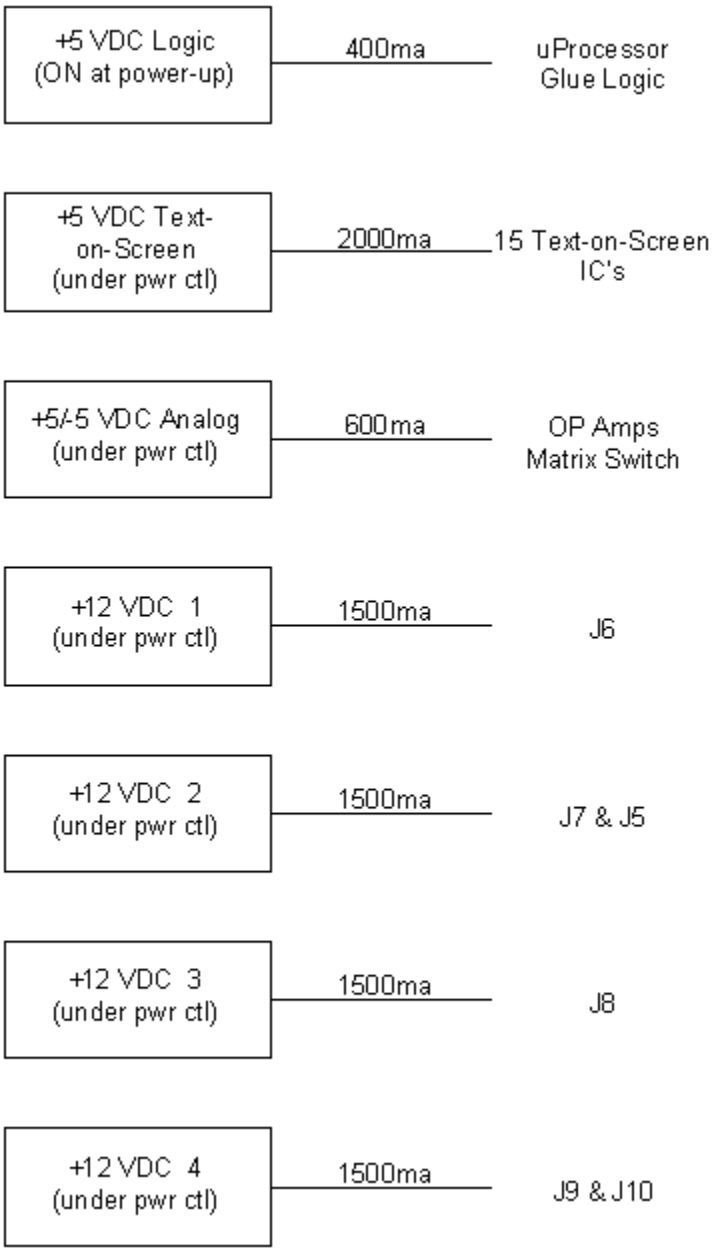

Figure 3 – Power Supply Summary

14.0 Power Control

To reduce the in-rush current at power-up the unit has power control to permit the uP to control the time between powering up the individual supplies. The power control is accomplished by using high side switches optically coupled to the uP. The following defines the power-up sequence:

Power applied to unit	uP/Control +5 VDC turns ON
Wait 500 msec	Analog +5/-5 VDC turns ON
Wait 500 msec	Text-on-Screen +5 VDC turns ON
Wait 500 msec	Camera 1 +12 VDC turns ON
Wait 500 msec	Camera 2 +12 VDC turns ON
Wait 500 msec	Camera 3 +12 VDC turns ON
Wait 500 msec	Camera 4 +12 VDC turns ON

15.0 Maintenance Port

The maintenance port provides two functions, a USB port to be used to configure the unit and a maintenance mode. The uP code will have a downloader so the unit's code can be changed during development or in the field. HyperTerminal would be used to download a text file containing hex format machine code. The following shows the maintenance port pin-out.

Pin	Function
1	USB +5 VDC
2	USB Data+ or Maintenance SCL
3	USB Data- or Maintenance SDA
4	USB ground and Maintenance ground
5	+5 VDC for maintenance unit
6	Grounded if maintenance unit attached

The USB-to-RS232 converter is powered by the USB +5 VDC pin. This permits the converter to be powered even if the +28 VDC power is not present. If a laptop is connected to the USB port the converter will be active and communicate with the USB driver software in the laptop. The uP can detect that the USB +5 VDC is present so it will know if the unit is attached to a laptop.

A relay is used to switch between USB mode and maintenance mode. If the USB +5VDC is present pins 2 & 3 are routed to the USB-to-RS232 converter, if the USB +5 VDC is not present the relay is not energized and pins 2 & 3 are routed to the uP aux. I2C bus. The I2C

bus is used to communicate with the external maintenance unit. The USB ground is used as the common ground for both modes.

The +5 VDC (pin 5) is used to power the external maintenance unit. Pin 6 is used to tell the uP if the maintenance unit is attached. If pin 1 is low and pin 6 is high the uP knows nothing is attached to the maintenance port.

16.0 Hour Meter

The Matrix Switch Unit shall contain an internal LCD hour meter to measure the power-on hours of the unit. This information will be used to track MTBF and provide information for future designs/projects. The top lid will need to be removed to see the hour meter.

17.0 Maintenance Unit

The maintenance unit is currently not part of the Matrix Switch Unit project (see Figure 4). VAC is developing the unit to assist in both the development and manufacturing efforts. VAC will provide the units as an additional product if BAE requires the unit. Figure 3 shows the Maintenance Unit. The unit will have an attached cable with a plug that will mate to the switch maintenance connector (J12). The enclosure will be a die cast aluminum box. A 40 X 4 line backlight LCD character display will be used. Four push buttons will be placed below the display. Push button function will be defined by text placed on the lower line of text. Using this approach permits the switch matrix code to define how the maintenance unit operates and how the push buttons are defined. There will be no uP or code in the maintenance unit, this removes the requirement of compatibility issues between two sets of code. Refer to the software section in this specification for the details on the initial implementation of the maintenance unit.

18.0 Configuration Files

The operation of the unit will be defined by configurations files that contain information loaded by the user(using HyperTerminal through the Maintenance port). The unit will have the capacity to store eight configuration files, the factory default file and seven user defined files. Each configuration file will contain the following information.

Text-on-Screen	Enable or disable text for each of the 15 inputs Define up to 26 characters of text for each of the 15 inputs Select character/background color
Direction Icons	Enable or disable icon for each camera Define a single icon for each camera Select character/background color
Input Selection for LCD 1	Define routing for all 16 input combinations

Input Selection for LCD 2	Define routing for all 16 input combinations
Input Selection for LCD 3	Define routing for all 16 input combinations
Input Selection for LCD 4	Define routing for all 16 input combinations

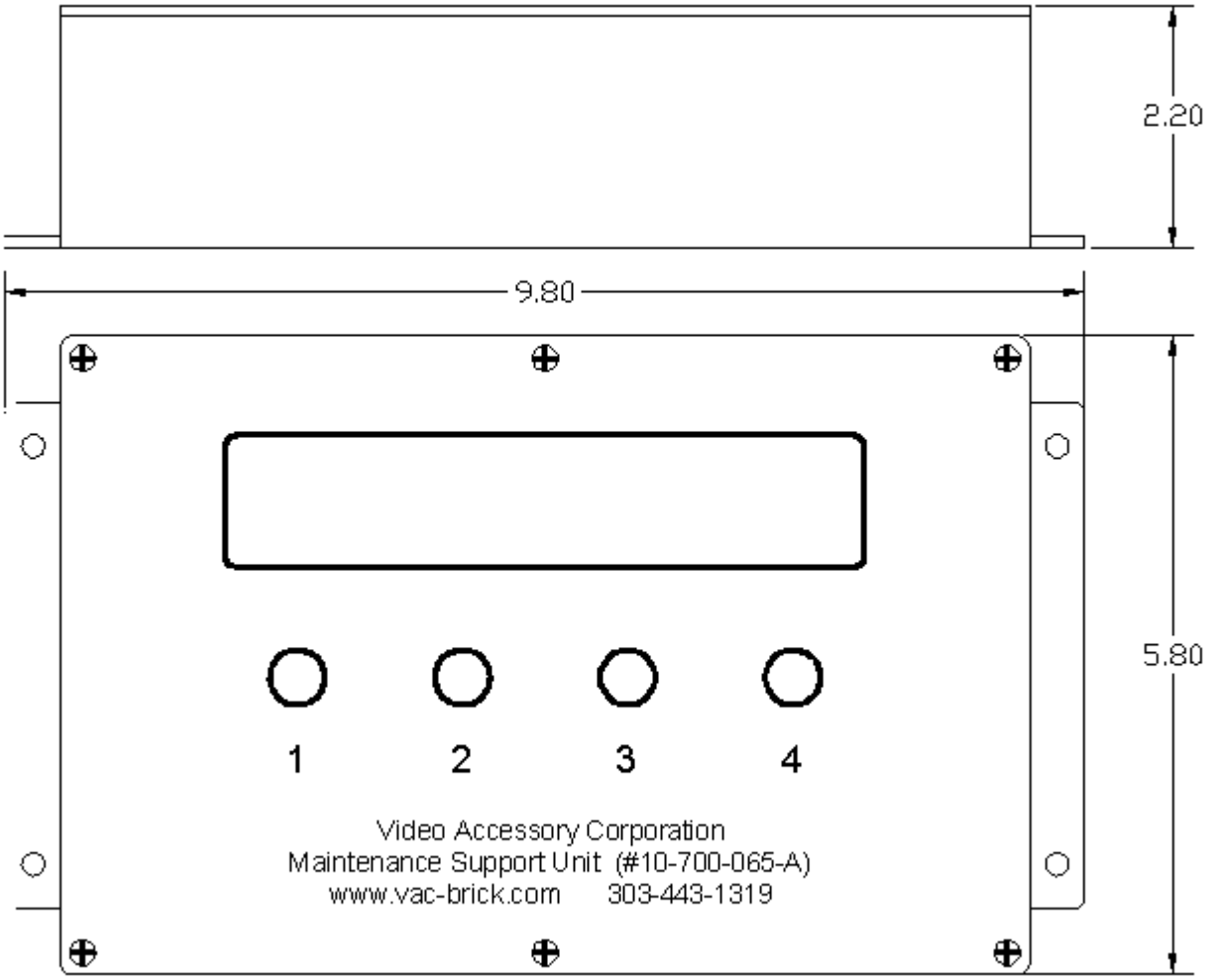

Figure 4 – Maintenance Support Unit

19.0 uProcessor Code

The Matrix Switch Unit uses a Microchip PIC18F6722 uP running at 40 MHz. A serial 128K byte EEPROM is attached to the uP to provide storage space for text to support the user interface, text-on-screen information, and additional code that could be swapped in and out of the uP Flash memory.

The following sections define how the code shall operate for each mode of operation. The final code operations manual will be a separate document that will include all of the code functions including how the downloader works, setting up a laptop to function with the Matrix Switch Unit, functions supported for the Maintenance Support Unit, entering text-on-screen strings, and manual operation of the unit.

19.1 Normal Operation

In the normal operation mode the unit will power-up, load the selected configuration file data, check the input selection bits, set the video paths per the initial input selection bit states, and then scan the input bits and the maintenance port for any changes. The input selection bits will be de-bounced using code.

19.2 Setup/Load Mode

The setup/load mode is entered by connecting a laptop to the unit via the maintenance port. In this mode normal operation stops, only manual control of the video routing is possible. HyperTerminal (or equivalent program) is used to communicate with the unit. The following outlines the planned commands supported by the initial release of production code.

Command	Description
INFO	Returns code rev, part #, Mfg. info, contact info, selected configuration file, BAE serial number.
HELP	Menu of all of the commands
LOAD	Download new code.
CONFIG	Load data for a selected configuration file
STATUS	Returns status of each video input and current routing paths
ROUTE	Permits manually routing any input to any output
BARS	Permits routing color bars to any combination of outputs
RUN	Unit jumps to normal operation with the laptop attached, any received character will cause unit to jump back to setup/load mode.
SBITS	Returns logic state of each input selection bit.
FILE	Select configuration file to use at power-up

19.3 Maintenance Mode

The maintenance mode is entered when the Maintenance Support Unit is attached to the unit. Normal RUN mode is stopped along with changes of the input/aux. bits. By using the 4 push buttons the user can maneuver through the menus and perform limited maintenance

functions. The following outline the planned functions supported by the Maintenance Support Unit.

Command	Description
INFO	Returns code rev, part #, Mfg. info, contact info, and config file, and the BAE serial number.
HELP	Menu of all of the commands
STATUS	Returns status of each video input and routing paths
ROUTE	Permits manually routing any input to any output
BARS	Permits routing color bars to any combination of outputs
SBITS	Returns logic state of each input selection bit.
PWR	Returns input voltage.

20.0 Manufacturing Support

To help support manufacturing of the units the following functions will be added to the internal PCBs.

Connector to support LEDs for each of the power supply outputs.
Small character LCD port to provide output during debug of boards.
Connector to support LEDs on loss-of-video logic signals.
On board uP reset push button
Test points along outer edge of PCB.

21.0 Unit Labels

BAE will supply the labels for the unit. A recessed area (0.010” deep) will be milled into the end of the box so the label has some protection from being pealed off. This label will contain BAE information and a serial number.

22.0 Test Data

Final test data will be filed by the BAE serial number. A final test plan will be generated and forwarded to BAE for approval/review. The test results will be maintained for future reference.

23.0 Thermal Management

To help reduce the heat released inside the box, major power supply components will be thermally connected to the box. Gap Pads will be used to thermally connect the components to the aluminum box.

24.0 Unit Repair

The current plan is for units that need repair or need upgraded to be shipped back to VAC. VAC will perform the needed tasks, perform the required tests, and ship the units back. The details of the time frames and costs for this function still need to be worked out between BAE and VAC.