VLBA Electronics Memo No. 78

(860822)

Electronics Packaging

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Most of the electronics of the VLBA is packaged in one of three forms: (1) metal modules that plug into rack-mounted bins, (2) circuit cards that plug into rack-mounted cages or bins, and (3) special-purpose units. The modules comprise the most general-purpose form of packaging, and are used for a large part of the analog and smaller digital subsystems. Cage-mounted cards, which may be of the wirewrap or multi-layer printed type, are used mostly in digital subsystems such as the formatter and correlator. These subsystems are large enough that the size and type of the card and their connectors should be chosen for most efficient construction of the particular electronic design. Special purpose units are typified by the front ends, in which all of the components that must be mounted in the vicinity of the feed are designed into a highly compact package. For the cards and special-purpose units, arbitrary specification of styles and dimensions is not likely to be helpful, and this memorandum is therefore concerned mostly with recommendations for modules and connectors. Some of these considerations have already been discussed in VLBA Electronics Memoranda Nos. 47, 51, 52, 53, 66, 67a, and 69. Cables are discussed in VLBA Electronics Memo No. 64. The main purpose of such recommendations is to minimize, as far as possible, the number of different types of metal parts, connectors, etc. for efficiency in procurement and maintenance. With a few exceptions, which are noted below, the VLBA packaging recommendations are based on those used for the VLA which are described in VLA Technical Report No. 31.

Modules and Bins

The modules and bins follow the design developed for the VLA in 1974. The front panel dimensions of the modules are the same as those of the commercially-available NIM (Nuclear Instrumentation Module) series, but the modules are longer and more ruggedly constructed. Dimensions of the VLA bins and modules are given in VLA Specification A13050N2, Rev. A, which is reproduced in VLA Technical Report No. 31, pp. 9-8 to 9-9. VLBA bins and modules differ mainly in the use of the OSP type coaxial connectors rather that the OMQ type of the VLA modules. Both OSP and OMQ are blind mating connectors manufactured by Omni-Spectra. The OMQ type is no longer available, and is replaced by the OSP type which is a superior design. The back panels of the modules and bins that carry these coaxial connectors have been redesigned for the VLBA. A list of drawing numbers for the VLBA bins and modules is given in Appendix A. These drawings refer to blank modules, i.e. they do not include holes or other details specific to a particular electronic design. Omni-Spectra part numbers for the OSP connectors are as follows:

4503-7941-00 Bulkhead plug for .141 SR coax (module)
4503-7985-00 Bulkhead plug for .085 SR coax (module)
4533-7388-02 Bulkhead plug for flexible coax (module)
4506-7941-02 Flange mount jack, floating, for .141 SR (bin)
4506-7985-02 Flange mount jack, floating, for .085 SR (bin)

The OSP connectors should be used for high frequency signals (up to 18 GHz), and any signals for which the phase stability is particularly critical. For other signals, including power and the monitor and control (M/C) bus, one of the Amp connectors listed in Table 1 should be used. Of these, the 42-pin mixed connector is the preferred one for general use. It contains 36 holes for signal pins, of which both crimp and wire-wrap types are available. The same holes will accommodate coaxial connectors of the AMP Subminiature Coaxicon series: from experience at the VLA these are <u>not</u> recommended. The mixed 42-pin connector also contains six larger holes which accommodate high current pins (used in VLBA power-supply modules) and coaxial connectors of the AMP Miniature Coaxicon series. The latter can be used for signals up to about 1 GHz for which the less precise electrical length of the mated connectors (as compared with that of the OSP connectors) is acceptable. The pin and socket designation for Miniature Coaxicon connectors is shown in Fig. 1. In cases where a large number of signal pins are required (e.g. for the output lines of the Switch Driver Module) the AMP 50-pin connector can be used, either in addition to, or instead of, the mixed 42-pin connector. If more power pins or miniature coaxicons are required the 20-large-pin connector can be used. These three connector blocks (the 42-mixed-pin, 50-small-pin and 20-large-pin types) are of the same overall dimensions and all require the same sized mounting holes in the bin and module panels. Usage of these three types alone would therefore be a simplification and they should cover all VLBA requirements. The 34-pin and 14-pin connectors listed in Table 1 have been used in modules in the VLA, mainly in cases when it was necessary to get a particular number of connections in the small back panel of a single-width module. They can be used on VLBA modules also, if this proves to be necessary.

A complication that has arisen in the use of the various types of AMP connectors described above involves the mating tolerances of the module- and bin-mounted parts. The pin lengths must be chosen to allow a sufficient range in the spacing of the two parts of the connector over which reliable contact is made. The signal pins are available in a number of lengths, as shown in Figure 2. In addition, for most of the connectors tested in Table 1, the module-mounted block that holds the pins is available in two different versions. These differ in the position of a shoulder that holds a spring clip which locks the pin into the block. Thus the pin length protruding from the front of the block is different in the two versions. To add to the potential for confusion, many of the AMP catalogs list only a

subset of the available pins and blocks. The mechanical design of the VLA modules was based on the use of the 42-pin mixed AMP connector (largely because this is the connector commonly used in the NIM series modules). The mechanical tolerances of the metal parts (as specified in the drawings listed in Appendix A) result in a gap of 0.05 ± 0.05 inches between the front surfaces of the module- and bin-mounted blocks (see also VLA drawing D1305P1). This gap is satisfactory when the long-type signal pins (see Fig. 2 and Table 1) are used with the 42-pin module-mounted block or the shallow-block design of the 14-, 34-, and 50-pin connectors in Table 1. The protrusion of the pin outside the front face of the block, in sample units that I have measured, is 0.31 inches for the 42 pin connector and 0.40 inches for the 50 pin connector. With the deep block design the measured pin protrusion on the 50 pin connector is only 0.24 inches. In the construction of the VLA, the deep block design was used for the 14-, 34-, and 50-pin connectors (perhaps because the shallow design was not available, or not in the catalog at hand, at that time). The long pins did not give reliable contacts when used with the deep blocks, and to overcome this the long-long pins (see Fig. 2 and Table 1) were substituted. The long-long pin was originally designed to be used as a special ground pin for situations in which it is required to connect the ground before the other pins. Consequently the range of available types of long-long pins is very limited. The long-long wire wrap pin in Table 1 was a special design made by AMP for NRAO. It consists of a 85931-3 wire-wrap post inserted and crimped in a 204219-1 long-long crimp pin. The pin protrusion with deep blocks and long-long pins is, as I measure it, the same as that with shallow blocks and long pins.*

In conclusion, it is recommended that for the 42 pin mixed connector, the one specified in Table 1 be used with the long-type pins. (Another 42-pin mixed block, AMP No. 202515-3, with pin protrusion similar to that of the 50-pin deep block, is listed in the catalogs. It should not be used for VLBA modules.) For the 14-, 34-, and 50-pin connectors the shallow block with the long pins is recommended. If the deep-block type is used, the long-long pins should be used with it.

In the 20-large-pin block the protrusion of the large pins and miniature coaxicons is the same as that in the 42-pin mixed block. The Mark III VLBI system also uses VLA-type modules and the 20-large-pin AMP blocks, and during development of this system by Alan Rogers and colleagues at Haystack, it was found advisable to reduce the size of the gap by 0.054 inches by milling out a corresponding depth of metal on the panel that supports the bin-mounted half of the connector. For the VLBA,

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* The terms 'long' and 'long-long' follow the usage of the AMP literature (see Fig. 2). At NRAO we have commonly used the terms 'short' and 'long', respectively to describe the same pins.

this modification is being used on the parts of the system constructed at Haystack, and in addition the dimensions of the 20-pin blocks are being milled to closer tolerances, as described in VLBA Acquisition Memorandum No. 63. To assure correct mating of all of the types of connectors discussed above, a series of measuring jigs is being designed in Charlottesville to check the length of each bin-slot and module between the connector mating surface and the front panel contacting surface. Use of these jigs will be described in a later memorandum.

Departures from the recommendations made above concerning module connectors should be made only for significant engineering reasons. In such cases the engineer concerned must be responsible for assuring satisfactory reliability and performance. This assurance should include a study of module and connector tolerances, and design of adjustment jigs if necessary.

Pin Assignments in AMP Connectors

Table 2 gives standard pin assignments for power and M/C bus connectors in the AMP connectors. The use of standard pins is intended to minimize the possibility of damage if a module is inserted into the wrong slot, and to simplify test and maintenance procedures. The power and M/C bus connection should normally be made through a connector in the lower right-hand corner of the module back panel (as viewed from the rear of the module) and the pin assignments in Table 2 apply only to the connector in this position. If only one connector is used it should be on this lower-right position, and if more than one connector is used and one of them is the mixed 42-pin type, the latter should be in the lower-right position.

For power supply modules, the 42 pin mixed connector and the large power-contact pins (0.094 inch diameter) that fit in the six large-sized holes of the 42-pin mixed connector should be used. The current rating of the large pins is 23 amps. Two such pins wired in parallel should be used for each terminal of the 5 volt supply, since the capacity of the 5 volt supply exceeds 23 amps. Pin numbers in the 42-pin mixed connector are as follows:

+5 V	pin nos.	6 and 39
+15 V	pin no.	5
+28 V or other voltage	pin no.	38
negative terminal	pin nos.	40 and 7

The usage of a module to supply a positive or negative voltage is determined by grounding the appropriate terminal in the rack wiring. The use of different positions for the positive terminal will prevent damage if a power supply module of the wrong voltage type is plugged into a power-supply slot.

Guide-Pin Keying of Module Connectors

As a further precaution against possible damage if a module is inserted into the wrong slot, the scheme shown in Figure 3 should be used for the keying of the guide pins and guide sockets at the corners of the connectors. The connector cannot be inserted if these guide screws at the corners of the two parts of the connector do not mate. The figure shows the module connector as seen looking towards the back of the module.

Racks and Air Flow

The two racks in the vertex room of each VLBA antenna will be of NRAO design and constructed of welded aluminum. Except for some additional panel-mounting holes, they will be identical to the VLA type B racks. Racks in the station building, other than recorder and computer racks, will be Equipto Heavy Duty type, size 170-070-030, with modification according to NRAO drawing No. C13030M2-2, Rev. C. This rack can accommodate seven VLA-type bins.

Temperature controlled air will be blown upwards through each rack, so some space for air flow should be left between modules in the bins. Ducting or side panels will be installed to channel the air through the rack. Modules which produce the most heat, such as power supplies, should be mounted near the tops of racks to minimize the amount of heat transferred to other modules.

RFI Shielding

The vertex room of the VLBA antenna is shielded as far as is practicable, but it must be assumed that interference generated within the vertex room can be picked up in the antenna feeds. Thus modules containing potentially interfering circuitry, i.e. circuitry that generates or transmits frequency components within the signal bands, should either be of the shielded type, or else all of the potentially-interfering circuitry should be in shielded boxes interconnected with coaxial cable, preferable of the .141 or .085 semi-rigid type. The monitor and control bus and interface card are examples of potentially-interfering circuitry.

The electronics room and observing room of the station building are sufficiently well shielded that unshielded modules can be used for digital circuitry.

Monitor and Control Bus

The monitor-and-control bus requires two balanced pairs of connectors: one for command (transmit) signals from the computer to the interface units, and the other for monitor (receive)

signals from the interface units to the computer. A cable containing two twisted pairs within a single outer shield will be installed in a daisy-chain arrangement from the computer to the units to be connected to the bus. The connectors for use with this cable are the 9-pin D-type with RFI shielded hoods. Since the cable contains signals going in both directions, there is no logical reason to assign a particular sex to any connector. For simplicity the following arbitrary choice has been made: connectors mounted on the cable will be plugs (male) and connectors mounted on the racks or other units will be sockets (female). There will be two sockets wired in parallel at each point where the bus connects with equipment, to allow the cable to be connected and then run on to the next piece of equipment in the chain. At the last unit the command lines of the bus will be terminated by a plug containing 100-ohm resistive loads.

Following are the recommended part numbers and the pin numbers to be used.

Cable: Belden 9842

Pin Numbers:	command signals (+)	red	pin no. 1
	command signals (-)	black	pin no. 2
	monitor signals (+)	white	pin no. 8
	monitor signals (-)	black	pin no. 9
	drain wire	(ground)	pin no. 5

Shield for Cable-Mounting Connector: Amp 1-745129-7 (inner)
1-745130-0 (outer)

RFI Gasket for Panel Mounting Connector: Amp 747024-3

9-pin D Connector. For good grounding should have tin-plated steel shell and grounding indents on plug. Units of this type with solder-pot contacts are:

Amphenol 17-12090-00	(socket, female)
Amphenol 17-22090-00	(plug, male)

Similar connectors with different wire contacts (e.g. crimp pins) could be used if preferred.

Nomenclature

Each type of module or other unit of the electronics is given a descriptive name and type number. This scheme is described in VLBA Electronics Memorandum No. 66.

Indicator Lights

Indicator lights should use the following color code.

1) Lights for which the on-condition indicates normal operation should be green.

2) Lights for which the on-condition indicates the system is not ready for operation or that a fault has occurred should be red.

3) Lights for which either the on- or off-condition may occur in normal operation should be yellow.

The above code should be used wherever possible, particularly for LED indicator lights. Fuse-holder lights on the power supply modules, which are amber to indicate a blown tube, are an exception.

Acknowledgements

Much of the information on module tolerances and connector problems was gathered by Larry D'Addario. Harry Dill prepared the drawing list in Appendix A.

Table 1. AMP Connector Parts for VLA and VLBA Modules

	Module		Bin	
	Block	Hood	Block	Hood
42-pin, mixed	204186-5	202394-2	202516-3	202579-5
20-pin, large	200485-1	202394-2	200459-1	202579-5
50-pin	200276-4 (shallow)	202394-2	200277-4	202579-5
	201358-3 (deep)	202394-2		
34-pin	200837-3 (shallow)	202434-4	200838-3	201350-2
	201357-3 (deep)	202434-4		
14-pin	201297-3 (shallow)	201347-4	201289-3	201363-4
	201355-3 (deep)	201347-4		
Contacts; Long:				
Crimp, #14 wire	201570-1		201568-1	
Crimp, 2 #18 wires	202725-1		202726-1	
Crimp, #24-20 wire	201578-1		201580-1	
Crimp, #24-20 wire	201330-1		201328-1	
Solder Tab	202236-1		202237-1	
Wire Wrap (.025x.025)	66460-6		66461-6	
Wire Wrap (.045x.045)	66471-6		66473-6	
Min. Coaxicon:				
RG 188 or twisted pair	201143-5		201144-5	
High Current:				
#14-12 wire	202422-1		202417-1	
Long-Long Pin:				
Crimp, #18-16 wire	204219-1			
Wire Wrap	601488-5			
Guide pin (corner)	200833-4	(zinc-plated brass)		
Guide pin (corner)	202514-1	(gold plated for grounding)		
Guide socket (corner)	203964-2	(zinc-plated brass)		
Guide socket (corner)	202512-1	(gold plated for grounding)		

Table 2. AMP Connector Pin Assignments

Signal	Connector 42* (Mixed)	20 (Large)	50	34	14
+5 V power	10	2**	C	C	C
+15 V power	16	15**	A	A	B
-15 V power	17	14**	E	E	E
+28 V power	29		F	F	A
-28 V power	28		J	J	P
-5.2 V power	11	8**	H	H	R
Power ground	34	1**	L,B	L,B	-
Signal ground	42		HH	NN	D
117 VAC hot	33		-	-	-
117 VAC common	41		-	-	-
MC Bus CMD (+)	8	13	z	EE	N
MC Bus CMD (-)	9	12	DD	KK	K
MC Bus MON (+)	14	7	BB	HH	J
MC Bus MON (-)	15	6	FF	MM	M

* See text for usage of large pins in power supply modules.

** These positions use power pins and all others for this connector use miniature coaxicons. Deviations from this standard mix of the two connector types will result in the need for special extender modules or cables.

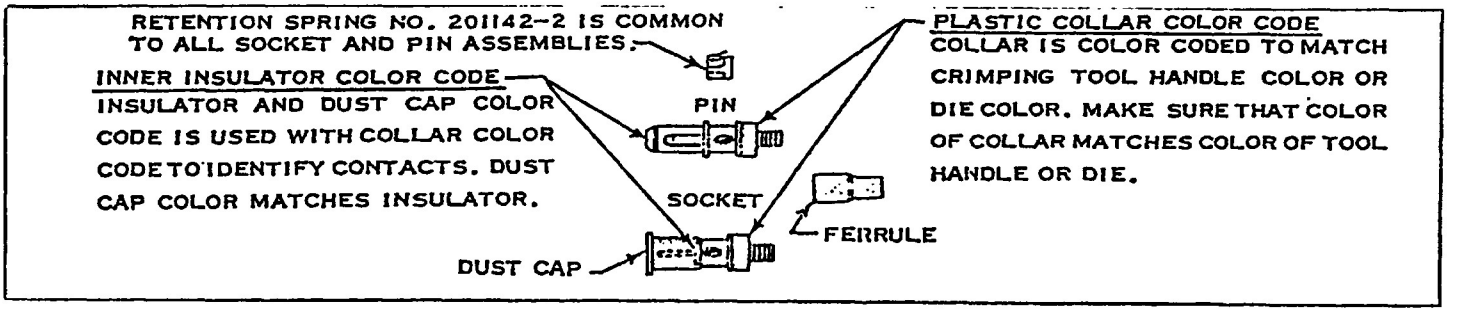

Figure 1. Pin/socket designation for miniature coaxicon connectors. Pins are male with respect to the outer and female with respect to the inner, and they are used in the module-mounted blocks. From Amp Instruction Sheet No. IS 1770.

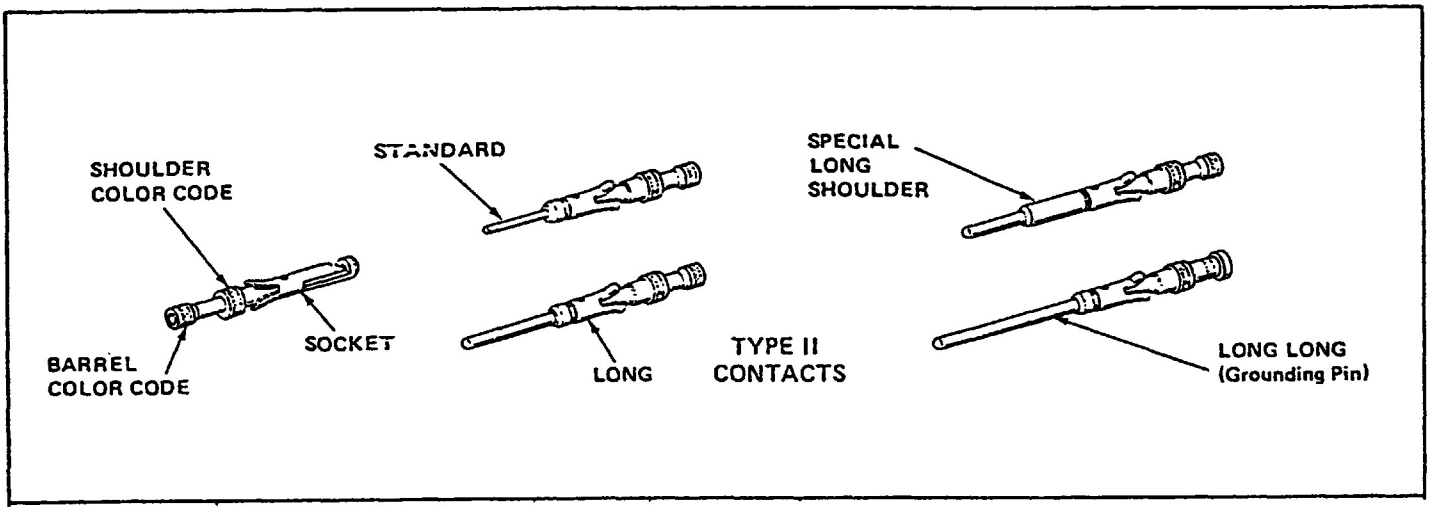

Figure 2. Some pin lengths for AMP series M connectors. From AMP Instruction Sheet No. IS 1379.

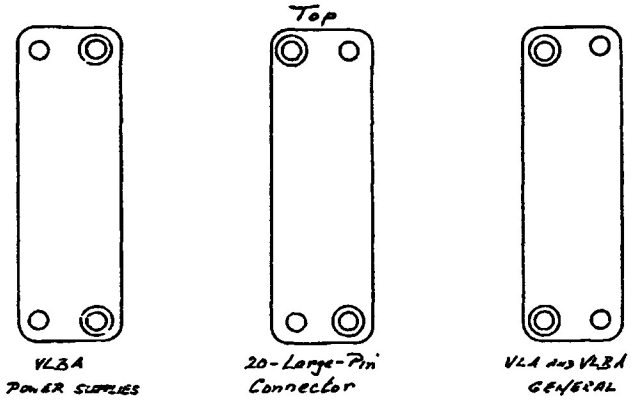

Figure 3. Guide-pin keying scheme. The diagram shows the module connector as seen when viewing the module from the rear.

APPENDIX A, Drawing List for Module Parts

PART	VLBA DWG #	# PER MODULE	VLA DWG #
1 WIDE SHIELDED MODULE			
PANEL, FRONT (1SA)	C53306M021	1	B13050M10
PANEL, REAR (1SA)	C53306M022	1	B13050M15
BAR SUPPORT (BOTTOM) (1SA)	D53306M004-1	1	~B13050M9-1
BAR SUPPORT (TOP) (1SA)	D53306M004-2	1	~B13050M9-1
SHIELD (1SA)	B53306M027-1	2	B13050M14-1
SIDE PLATE	D53306M005	2	~C13050M12 &M13
CONNECTOR SHIELD (1SA)	B53306M028	1*	~B13050M11-1
BAR SUPPORT, TOP (HALF SHIELD)	D53306M004-3	1*	~B13050M9-5
GUIDE	B53306M018	4	B13050M4
2 WIDE SHIELDED MODULE			
PANEL, FRONT (2SA)	C53306M023-1	1	
PANEL, REAR (2SA)	C53306M024-1	1	
BAR SUPPORT, BOTTOM (2SA)	D53306M025-1	1	~B13050M9-2
BAR SUPPORT, TOP (2SA)	D53306M026-1	1	~B13050M9-2
SIDE PLATE	D53306M005	2	~C13050M12 &M13
SHIELD (2SA)	B53306M027-2	2	B13050M14-2
REAR SIDE SHIELD	B53306M006	1*	
GUIDE	B53306M018	4	B13050M4
3 WIDE SHIELDED MODULE			
PANEL, FRONT (3SA)	C53306M023-2	1	
PANEL, REAR (3SA)	C53306M024-2	1	
BAR SUPPORT, BOTTOM (3SA)	D53306MO25-2	1	~B13050M9-3
BAR SUPPORT, TOP (3SA)	D53306M026-2	1	~B13050M9-3
SHIELD (3SA)	D53306M027-3	2	B13050M14-3
SIDE PLATE	D53306M005	2	~C13050M12 &M13
REAR SIDE SHIELD	B53306M006	1*	
GUIDE	B53306M018	4	B13050M4
4 WIDE SHIELDED MODULE			
PANEL, FRONT (4SA)	C53306M023-3	1	
PANEL, REAR (4SA)	C53306M024-3	1	
BAR SUPPORT, BOTTOM (4SA)	D53306M025-3	1	~B13050M9-4
BAR SUPPORT, TOP (4SA)	D53306M026-3	1	~B13050M9-4
SHIELD (4SA)	D53306M027-4	2	B13050M14-4
SIDE PLATE	D53306M005	2	~C13050M12 &M13
REAR SIDE SHIELD	B53306M006	1*	
GUIDE	B53306M018	4	B13050M4
1 WIDE UNSHIELDED MODULE			
PANEL, FRONT	C53306M044	1	B13050M1
PERFORATED COVER	D53306M045	1	C13050M7
BAR SUPPORT (TOP AND BOTTOM)	C53306M046	2	B13050M3
PANEL, REAR	C53306M047	1	B13050M2
SIDE PLATE	C53306M048	1	~B13050M6
FASTENER, PERFORATED COVER	B53306M049	2	B13050M4
GUIDE	B53306M018	2	B13050M4

2 WIDE UNSHIELDED MODULE			
PANEL, FRONT (2UA)	C53306M013-1	1	B13050M19-1
COVER, PERFORATED (2UA)	C53306M014-1	2	B13050M22-1
PANEL, REAR (2UA)	C53306M015-1	1	B13050M24-1
BAR SUPPORT	C53306M016	4	B13050M23
SIDE PLATE	C53306M017	2	~B13050M18
GUIDE	B53306M018	4	B13050M4
SIDE PLATE OPTION (SOLID)	B53306M032-1	2*	
SIDE PLATE OPTION (PERF.)	B53306M032-2	2*	
PLATE MOUNT OPTION	B53306M033	12*	
3 WIDE UNSHIELDED MODULE			
PANEL, FRONT (3UA)	D53306M013-2	1	B13050M19-2
COVER, PERFORATED (3UA)	C53306M014-2	2	B13050M22-2
PANEL, REAR (3UA)	C53306M015-2	1	B13050M24-2
BAR SUPPORT	C53306M016	4	B13050M23
SIDE PLATE	C53306M017	2	~B13050M18
GUIDE	B53306M018	4	B13050M4
SIDE PLATE OPTION (SOLID)	B53306M032-1	2*	
SIDE PLATE OPTION (PERF.)	B53306M032-2	2*	
PLATE MOUNT OPTION	B53306M033	12*	
4 WIDE UNSHIELDED MODULE			
PANEL, FRONT (4UA)	C53306M013-3	1	B13050M19-3
COVER, PERFORATED	C53306M014-3	2	B13050M22-3
PANEL, REAR (4UA)	C53306M015-3	1	B13050M24-4
BAR SUPPORT	C53306M016	4	B13050M23
SIDE PLATE	C53306M017	2	~B13050M18
GUIDE	B53306M018	4	B13050M4
SIDE PLATE OPTION (SOLID)	B53306M032-1	2*	
SIDE PLATE OPTION (PERF.)	B53306M032-2	2*	
PLATE MOUNT OPTION	B53306M033	12*	
6 WIDE UNSHIELDED MODULE			
PANEL, FRONT (6UA)	C53306M013-4	1	B13050M19-4
COVER, PERFORATED (6UA)	C53306M014-4	2	B13050M22-4
PANEL, REAR (6UA)	C53306M015-4	1	B13050M24-4
BAR SUPPORT	C53306M016	4	B13050M23
SIDE PLATE	C53306M017	2	~B13050M18
GUIDE	B53306M018	4	B13050M4
SIDE PLATE OPTION (SOLID)	B53306M032-1	2*	
SIDE PLATE OPTION (PERF.)	B53306M032-2	2*	
PLATE MOUNT OPTION	B53306M033	12*	

* - Designates parts that are optional. Use of these may require standard parts additional to, or different from, those listed for the particular type of module.

~ - The VLBA parts are similar to the VLA parts, but are not exact replacements. See the drawings for details.