Appendix H
Macro-Command Details

Macro-commands which are sent from MDP to FPP-E are described in this appendix. Structure of tables in FPP-E is also described.

Revision Record of Appendix H tables:

Revision Number	Date	Remarks
Rev. 1.0	2000.02.15	First version of macro-command and FPP-E tables
Rev. 3.0	2001.04.16	Version for proto-model electrical test - Define extract region/map center row/column - Update FG Observable Definition Table and Frame Definition Block - Update SP operational parameters and map region parameters to be consistent with MDP - Delete IV Notes and V FPP Configuration Parameters
Rev. 4.0	2002.06.18	No change
Rev. 4.1	2002.12.03	Type correction and missing label additions - H-3 Added “size(bits) in filtergraph observable definition table. - H-7 Added “(bits)” in field size of map table - H-8 Region 2 → Region 3 in spectral extract table.
Rev. 5.0	2005.04.12	Complete update to the last version

FPP Operational Parameters

(21 April, 2004)

H. FPP Macro Commands:

The formats of the MDP macro commands were shown in Tables 6.7-1 and 6.7-2 for the Filtergraph and the Spectro-Polarimeter respectively. Each of these has fields for operational parameters and region parameters. These fields are described in detail along with tables referenced by the parameters.

H.1 Filtergraph Operational Parameters

This field occupies bytes 9 through 16 (8 bytes total) in the filtergraph macro commands as shown in Table H.1-1.

Table H.1-1 Operational Parameters for Filtergraph

Byte		Bit		Field Name	Comments
Pos	Size	Pos	Size		
9	1			Observable ID	specifies observing table
10	1			Frame Definition Block ID	frame table
11	2				
		0	5	Wavelength ID	
		5	11	Wavelength Offset	signed, unit = 4mÅ
13	2				
		0	15	Exposure (or Integration Cycles)	
		15	1	Dark Frame Flag	
15	2				
		0	5	Wavelength Scan Positions	
		5	11	Wavelength Scan Step Size	unit = 4mÅ

These parameters and related tables are described below:

1. Observable ID: Specifies which observing table to use. This table then specifies the type of observation and the data products. There are a maximum of 256 tables loaded. The table format has a header section followed by parameter blocks for each type of exposure made for the observable. For example, a Stokes IQUV observable would have

4 or 8 parameter blocks while a simple Hα image would have just one. Additionally, flatfielding and other calibration operations may also be defined as "pseudo" observables. A flatfield observable may contain a single frame definition but the generating function would take multiple frames at PZT offsets stored in a table. The Observable ID table header is 4 bytes as shown in Table H.1-2 below:

Table H.1-2 Filtergraph Observable ID Table Header

Byte		Bit		Field Name	Comments
Pos	Size	Pos	Size		
0	1			Observable ID	same as in macro command
1	1			Generating Function ID	
2	1				
		0	4	Number of Images	
		4	4	Repeat Count	for FG Stokes Maps
3	1			Spare	not used

The parameter definitions are:

- Observable ID –This is the same ID in the macro command. It is used to find the right table.
- Generating Function ID – Specifies which internal function to use.
- Number of Images – The number of exposures for each cycle. Each exposure will have a parameter block in the second part of this table.
- Repeat count - Another repeat count defining the number of cycles that will be accumulated in memory.
- Spare - empty

Parameter blocks for each image directly follow the header. The number of these is specified by the "number of images" parameter in the header. The format is shown in Table H.1-3 where the byte offset column is shown for the first parameter block. Subsequent parameter blocks (if any) are appended. Each parameter block is 6 bytes. Hence the second parameter block, if any, would start at a byte offset of 10 from the start of the table.

The parameter definitions are listed below. Note that the DMA page 2, 3, and 4 scale and operation bits work the same way as page 1.

- Delay – an optional delay in unit of 0.1s before the first integration
- λ offset – units are 1mÅ, this offset is added to any general offset specified in the macro command (which uses units of 4 mÅ).
- modulator phase – the PMU phase for this particular exposure. Note that this is the desired phase for the actual integration.
- DMA mode – 0 for 4 page (IQUV) mode and 1 for single page mode
- DMA page 1 scale – 0 for no scaling, 1 to ÷2 before adding or subtracting
- DMA page 1 operation – this specifies how the camera data is loaded into smart memory buffer 1. The load and load complement operations are used to initialize an accumulation. They replace the current contents with the camera readout or the negative (2's complement) of the camera readout. The add or subtract operations add or subtract the camera values with the current contents. 00 is load, 01 load complement, 10 add, and 11 is subtract.

Table H.1-3 Filtergraph Observable ID Table Parameter Block

Byte		Bit		Field Name	Comments
Pos	Size	Pos	Size		
0	2				
		0	12	Delay	Units of 0.1 s
		12	4	modulator phase	
2	2			λ offset	unit = 1mÅ, signed
4	2			smart memory DMA parameters	
		0	2	unused	
		2	1	buffer mode	0 for four sub-buffers, 1 for a single buffer
		3	1	unused	
		4	1	buf 1 scale	0 for no scale, 1 for ÷ 2
		5	2	buf 1 operation	00 load, 01 load complement 10 add, 11 subtract
		7	1	buf 2 scale	0 for no scale, 1 for ÷ 2
		8	2	buf 2 operation	00 load, 01 load complement 10 add, 11 subtract
		10	1	buf 3 scale	0 for no scale, 1 for ÷ 2
		11	2	buf 3 operation	00 load, 01 load complement 10 add, 11 subtract
		13	1	buf 4 scale	0 for no scale, 1 for ÷ 2
		14	2	buf 4 operation	00 load, 01 load complement 10 add, 11 subtract

2. Frame Definition Block ID: Returning to Table H.1-1, the second field defines the characteristics of the CCD frames to be used for making the data. The CCD

characteristics include, summing mode, size of extract region, shutter mode and CCD readout mode. The format of frame definition block ID is given in Table H.1-4.

Table H.1-4 Filtergraph Frame Definition Block

Byte		Bit		Field Name	Comments
Pos	Size	Pos	Size		
0	1			Frame Definition Block ID	same as in macro command
1	1				
		0	4	CCD mode	not used presently
		4	4	Mask position	
2	1				
		0	2	Row summing (N/S on sun)	
		2	2	Column summing (E/W on sun)	
		4	2	Shutter mode	1 for shutterless
		6	2	Not used	
3	1			Width on CCD (N/S on sun)	
4	1			Height (E/W on sun)	
5	1				
		0	2	Row binning	
		2	2	Column binning	
		4	4	Not used	

3. Wavelength ID: This parameter defines the reference wavelength ID. There are two blocking filters with 6 filters each. Since the BFI and NFI cannot be used simultaneously there are 12 independent blocker specifications that are valid. Each broad band filter (BFI) has a single ID but some tunable filter (NFI) bands contain several lines and each has an ID. There are also some special ID's such as “don't move”. For the NFI, the ID defines the base wavelength for all the images required for the observable. The base wavelength is modified by the offsets specified in the Observable Definition Table as well as by the composite velocity correction supplied by the MDP. The temperatures of the individual elements in the tunable filter also affect the tuning positions.

4. Wavelength Offset Steps: A NFI observable base wavelength may be offset using this

parameter. This is necessary to allow the same observable ID to be used under different conditions. The 11-bit field allows a range of –1024 to +1023 steps representing approximately a 8 Å range. The unit is 4 m Å.

5. Exposure: For shuttered exposures, this defines exposure duration in milliseconds. The range is 0 to 32767. In shutterless mode this parameter defines the number of frames to be accumulated prior to data product output.

6. Dark Frame Flag: When this bit is set (1), the data product is constructed from dark frame(s). The shutter is not opened.

7. Wavelength Scan Positions: Number of Positions in a wavelength scan (max 32). A value of 0 in this field, indicates no wavelength scan. If non-zero, the value plus one is used to specify the number of repeats of the observable. The first execution is done at the specified wavelength plus offset (from parameters 3 and 4 above). Before each subsequent execution, the wavelength scan step size is added to the current position. This is intended primarily for a set of NFI filtergraphs across a spectral line.

8. Wavelength Scan Step Size: $\Delta\lambda$ between scan positions. The units are 4mÅ. This field is treated as a signed 11 bit integer.

H.2. Spectrograph Operational Parameters

This field occupies bytes 9 through 16 (8 bytes total) in the spectrograph macro commands as shown in Table H.2-1. Note that the last 3 bytes are not used.

Table H.2-1 Operational Parameters for Spectrograph

Byte		Bit		Field Name	Comments
Pos	Size	Pos	Size		
9	2				
		0	2	CCD summing in slit direction	Used as power of 2
		2	8	slit scan step size	
		10	1	scan summing	
		11	1	repeat flag	
		12	4	extract table	
11	2				
		0	11	number of slit positions	
		11	1	sides	1 for both beamsplitter sides
		12	4	number of integration cycles	
13	1				
		0	1	bad pixel correction flag	presently not used
		1	1	tip tilt reset flag	also forces a new CT reference
		2	6	spares	
14	3			spares	

These parameters and related tables are described below:

1. CCD summing in slit direction: A value of 0 indicates no CCD summing and 1 indicates summing along the slit but not in the spectral direction of the CCD image. Hence 1 does 2×1 CCD summing. And zero does no summing (1×1). Values of 2 and 3 in this field are not supported but would do 4×1 and 8×1 summing if they were. Note that CCD summing in the spectral direction is not possible.

2. slit scan step size: add one to this quantity to get the number of slit steps between each position for a slit scan. Hence zero steps the slit one position for each integration.

3. scan summing: a zero in this one bit field indicates no summing of consecutive slit positions. A one indicates that the IQUV integration continues for 2 slit positions. This is also called the fast map mode.

4. repeat flag: 0 indicates that the slit scan is done only once, 1 indicates that it repeats

until stopped.

5. extract table: the index of the extract table. The table controls the height and width of the CCD actually sent down in telemetry packets.

6. number of slit positions: The number of slit positions for a spectrograph observations. It should not be zero. Note that the position of the center is specified by the map center elsewhere in the macro command.

7. sides: controls whether both sides of the CCD are downlinked or just the LHS. Each side comes down as a separate set of images. Zero chooses the single side case.

8. number of integration cycles: add one to this quantity to get the number of half rotations of the PMU for an integration. The range is 1 to 16. Each integration uses 8 CCD exposures.

9. bad pixel correction flag: this is currently not used but is reserved to activate an optional bad pixel correction algorithm.

10. tip tilt reset flag: when set, this flag causes the tip tilt mirror to re-center before the observations begin. It also forces a reference frame update for the CT. If the CT is not operating or does not perform the update for some reason, the observation can be started with a SP_RESUME command.

H.3. Filtergraph Extract Region Parameters

This field occupies bytes 17 through 20 in the filtergraph macro commands as shown in Table H.3-1.

Table H.3-1 Extract Region Parameters for Filtergraph

Byte		Bit		Field Name	Comments
Pos	Size	Pos	Size		
17	2			Extract Region Center Column (E-W)	
19	2			Extract Region Center Row (N-S)	

1. Extract Region Center Row:
2. Extract Region Center Column:

These parameters define the position of the extract window within the field of view. The center position of extract region is given with the definition of coordinate described below:

Coordinate direction	Column = E-W direction (positive toward the west)
	Row = N-S direction (positive toward the north)
Coordinate origin	Center in 4Kx2K CCD
Coordinate Scale	1 digit = 1 arcsec

H.4. Spectrograph Map Region Parameters

This field occupies bytes 17 through 20 in the spectrograph macro commands as shown in Table H.4-1.

Table H.4-1 Map Region Parameters for Spectrograph

Byte		Bit		Field Name	Comments
Pos	Size	Pos	Size		
17	2			Map center position	
19	2			Spare	

1. Map Center Position: Defines the central slit scan position for the map with the definition of coordinate described below:

Coordinate direction	E-W direction (positive toward the west)
Coordinate origin	0 (at center)
	positive (up to ~1000 toward West)
	negative (up to ~–1000 toward East)
Coordinate Unit	Slit position number (0.16 arecsec)

Spectrographic observations which comprise two or more “separated” maps can be implemented as independent macro-commands with different starting map positions.

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