

## ASMA Instruction Status

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### Notices

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### Introduction

ASMA is somewhat behind in instruction implementation. This document describes the plan for the immediate future and generally going beyond that. Over time this document will be updated with the implementation status and next set of planned changes.

## ASMA Instruction Status

**In general, ASMA supports all machine instructions for all mainframe architectures starting with S/360 models through the systems defined by the SA22-7832-13 version of the *IBM® z/Architecture® Principles of Operation* manual released in May, 2022.**

Machine instructions are supported by ASMA for instructions defined by versions -11, -12, and -13, as described in the following three sections devoted to each version. All previous PoO manual versions and systems are also supported but not included in this document which is focused on bringing ASMA machine instruction support current with the latest PoO manual.

Extended Mnemonics are more restrictive. See the “Extended Mnemonics” section for details on extended mnemonics requiring ASMA enhancements for support.

Because ASMA instructions are defined by the MSL files (see the `asma/msl` directory), this is largely a plan for MSL. The last features implemented in `s390x-inst.msl` when this document was created, are those instructions added by the PoO manual SA22-7832-11, released in September, 2017.

The next version of the PoO manual beyond -11 was -12, released in September, 2019. The latest PoO manual, -13, was released in May, 2022. Adding these instructions makes ASMA current. Most, but not all, new instructions are in the area of new floating point instructions and vector instructions. Of most interest by the users of ASMA are support for new instructions that are of more general use. “General use” includes privileged instructions for bare-metal programs. All machine instructions matching this description were implemented and described by “Change 4” of this document’s change history.

Addition of the remaining instructions, bringing ASMA current with the latest PoO manual, -13, are described by “Change 7” of this document’s change history.

This table documents the general status of ASMA instruction development for the -11, -12, and -13 PoO manuals by chapter. The “Type” column identifies whether the instructions defined by the chapter are available to all programs (general) or only programs executing in privileged state (privileged). The three status columns identify the status of the chapter contents within ASMA:

- **Implemented** – new instructions introduced by the chapter and implemented by ASMA,
- **Partial** – new instructions introduced by the chapter and only partially implemented by ASMA,
- **Implement** – new instructions introduced and ASMA does not yet support the new instructions, and
- **No change** – no new instructions were introduced by the chapter in the PoO manual version.

## ASMA Instruction Status

Instructions	Type	Chapter	-11 Status	-12 Status	-13 Status
General	general	7	Implemented	Implemented	Implemented
Decimal	general	8	Implemented	No change	No change
FP Overview & Support	general	9	Implemented	No change	No change
Control	privileged	10	Implemented	Implemented	Implemented
I/O	privileged	14	Implemented	No change	No change
Hexadecimal FP	general	18	Implemented	No change	No change
Binary FP	general	19	Implemented	No change	No change
Decimal FP	general	20	Implemented	No change	No change
Vector Overview & Support	general	21	Implemented	Implemented	No change
Vector Integer	general	22	Implemented	Implemented	No change
Vector String	general	23	Implemented	Implemented	No change
Vector FP	general	24	Implemented	Implemented	No change
Vector Decimal	general	25	Implemented	No change	Implemented
Specialized Function Assist	general	26	--	--	Implemented

Report on the SATK github repository web site: <https://github.com/s390guy/SATK> Issues page any instruction unsupported or incorrectly supported by ASMA that is a

- machine instruction introduced **prior to and including the -13 PoO** version, May, 2022, or
- extended mnemonic prior to **SA22-7832-00**, December, 2000 (pre-z/Architecture).

Based upon the analysis of the remaining machine instructions requiring implementation, bringing ASMA current with the latest PoO version will proceed to completion. All chapters will eventually be shown as “Implemented” or “No change”. As reflected in the previous table, all of the required work to bring ASMA current with the latest PoO manual, -13, relates to vector instructions and the nine new instructions in Chapter 26. This work was completed with “Change 7” of this document.

Following implementation of all new instructions, the Machine Specification Language enhancements required for the new extended mnemonics using bits beyond 15, introduced by z/Architecture, will be made. The **plan** for the actual extended mnemonics implementation will be addressed in the future. See the “Extended Mnemonics” section for base mnemonics present in Chapter 7 (-13) having defined extended mnemonics. Extended mnemonics introduced in other chapters are yet to be researched.

In the tables in the following sections, instructions, MSL formats, and programming notes in **bold** text require implementation. As implementation occurs, the bold text font will be changed to normal text font.

## ASMA Instruction Status

### Change History

Change	Date	Description
1	4 Sep 2022	Initial release.
2	5 Sep 2022	-11 PoO fully supported with addition of two instructions that rename instructions released in the -10 PoO, chapter 24.
3	6 Sep 2022	Completed research for -12 and -13 PoO versions of chapters 7, 8, 10, and 14 instruction changes. Ready for implementation.
4	8 Sep 2022	Provided BIC extended mnemonic analysis. Implemented all instruction to current level (-13) for chapters 7, 8, 10, and 14. Added appendix describing issues and enhancements required for support of all extended mnemonics.
5	13 Sep 2022	Completed analysis of <b>all</b> instruction defining chapters required to bring ASMA <b>machine</b> instruction support current with the latest PoO (-13).
6	14 Sep 2022	Completed implementation of vector instructions missing from original release by PoO -10. All machine instructions prior to and including the -11 PoO are now supported by ASMA. Only some vector instructions and Chapter 26 still require work.
7	17 Sep 2022	Completed implementation of all machine instructions introduced prior to the -13 PoO manual, consisting of machine introductions introduced by the -12 and -13 manuals. These instructions are all vector instructions or part of the new facility assist, chapter 26 of the -13 manual.

## ASMA Instruction Status

### SA22-7832-11 – September, 2017

No new decimal instructions, Chapter 8, nor new I/O Instructions, Chapter 14, were added. Instructions that operate upon decimal floating point data, Chapter 20, and decimal data acted upon by vector instructions, Chapter 25 *were* added. Those additions have been implemented in ASMA.

Upon inspection of the actual MSL files, nearly all new instructions **WERE** already added to the MSL files for the -11 version of the PoO manual except for the mnemonic change for two instructions in Chapter 24.

During the analysis of floating point and vector instructions, ten vector instructions were found to be only partially implemented within the MSL. These ten were actually introduced in the -10 version of the PoO. By adding these ten instructions' mnemonics to the MSL s390x -vector `iset` statement (the statement defining the VECTOR FACILITY), the instructions were made visible to the assembler for z/Architecture target assemblies and those targets including all instructions.

By incorporating the mnemonic name changes, ASMA is current with the -11 version of the PoO manual for all -11 and previous machine instructions.

At this point ASMA is now requiring enhancements for -12, released in September, 2019 and -13, released in May, 2022. ASMA is now three years behind.

### General Instructions – Chapter 7

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Other Notes
AGH	7-28	31	RXYA	yes	See BIC EM table below
BIC	7-39	31	RXYB	yes	
KMA	7-78	33	RRFB3	yes	
CLT	7-155	26	RSYB	yes	
CLGT	7-155	26	RSYB	yes	
LGG	7-274	32	RXYA	yes	
LGSC	7-275	32	RXYA	yes	
LLGFSG	7-274	32	RXYA	yes	
MG	7-304	31	RXYA	yes	
MGRK	7-304	31	RRFA1	yes	
MGH	7-305	31	RXYA	yes	
MSC	7-307	31	RXYA	yes	
MSRKC	7-307	31	RRFA1	yes	
MSGC	7-307	31	RXYA	yes	
MSGRKC	7-307	31	RRFA1	yes	
PRNO	7-346	29	RRE	yes	
RISBGN	7-363	26	RIEF	yes	
STGSC	7-383	32	RXYA	yes	
SGH	7-388	31	RXYA	yes	

## ASMA Instruction Status

### BIC Extended Mnemonics (EM)

The BIC instruction utilizes an extended operation code in bits 40-47. Because current extended mnemonic support utilizes the extended operation in bits 8-11, it is not possible to define the BIC extended mnemonics by overloading the extended operation field with the fixed mask. The new support for extended mnemonics is required for the BIC instruction.

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
<b>BIO</b>	7-40		?		M1 = 1
<b>BIP</b>	7-40		?		M1 = 2
<b>BIH</b>	7-40		?		M1 = 2
<b>BIM</b>	7-40		?		M1 = 4
<b>BIL</b>	7-40		?		M1 = 4
<b>BINZ</b>	7-40		?		M1 = 7
<b>BINE</b>	7-40		?		M1 = 7
<b>BIZ</b>	7-40		?		M1 = 8
<b>BIE</b>	7-40		?		M1 = 8
<b>BINM</b>	7-40		?		M1 = 11 or B
<b>BINL</b>	7-40		?		M1 = 11 or B
<b>BINP</b>	7-40		?		M1 = 13 or D
<b>BINH</b>	7-40		?		M1 = 13 or D
<b>BINO</b>	7-40		?		M1 = 14 or E
<b>BI</b>	7-40		?		M1 = 15 or F

### Programming Notes

Note #	Description
26	Miscellaneous-Instruction Extensions Facility 1
29	Message-Security-Assist Extension 5
31	Miscellaneous-Instruction Extensions Facility 2
32	Guarded Storage Facility
33	Message-Security-Assist Extension 8

## Control Instructions – Chapter 10

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
IRBM	10-30	11	RRE	yes	
TPEI	10-169	12	RRE	yes	

### Programming Notes

Note #	Description
11	Insert-Reference-Bits-Multiple Facility
12	Test Pending External Interruption Facility

## ASMA Instruction Status

### Vector Overview and Support Instructions – Chapter 21

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
VLEF	21-7	A	VRX	yes	
VLEG	21-7	A	VRX	yes	
VLBB	21-10	A	VRX	yes	
VPKLS	21-14	A	VRRB	yes	
VSEL	21-17	A	VRRE1	yes	

#### Programming Notes

Note #	Description
A	Vector Facility introduced in PoO version -10

### Vector Integer Instruction – Chapter 22

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
VNC	22-5	A	VRRC2	yes	
VCH	22-8	A	VRRB	yes	
VCHL	22-9	A	VRRB	yes	

#### Programming Notes

Note #	Description
A	Vector Facility introduced in PoO version -10

### Vector Floating Point Instructions – Chapter 24

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
VFLL	24-25		VRRA4	yes	Changed Mnemonic from VLDE
VFLR	24-26		VRRA	yes	Changed Mnemonic from VLED

## SA22-7832-12 – September, 2019

### General Instructions – Chapter 7

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
NCRK	7-34	34	RRFA1	yes	
NCGRK	7-34	34	RRFA1	yes	
MVCRL	7-300	34	SSE2	yes	
NNRK	7-308	34	RRFA1	yes	
NNGRK	7-308	34	RRFA1	yes	
NORK	7-311	34	RRFA1	yes	
NOGRK	7-311	34	RRFA1	yes	
NXRK	7-311	34	RRFA1	yes	
NXGRK	7-311	34	RRFA1	yes	
OCRK	7-314	34	RRFA1	yes	
OCGRK	7-314	34	RRFA1	yes	
POPCNT	7-365	34	RRFC	yes	
SELR	7-376	34	RRFA2	yes	
SELGR	7-376	34	RRFA2	yes	
SELFHR	7-376	34	RRFA2	yes	

#### Programming Notes

Note #	Description
34	Miscellaneous-Instruction-Extension Facility 3

### Vector Overview and Support Instructions – Chapter 21

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
VLEBRH	21-7	unnumbered	VRX	yes	
VLEBRF	21-7	unnumbered	VRX	yes	
VLEBRG	21-7	unnumbered	VRX	yes	
VLBRREP	21-8	unnumbered	VRX	yes	
VLLEBRZ	21-8	unnumbered	VRX	yes	
VLBR	21-9	unnumbered	VRX	yes	
VLER	21-10	unnumbered	VRX	yes	
VSTEBRH	21-22	unnumbered	VRX	yes	
VSTEBRF	21-22	unnumbered	VRX	yes	
VSTEBRG	21-22	unnumbered	VRX	yes	
VSTBR	21-22	unnumbered	VRX	yes	
VSTER	21-24	unnumbered	VRX	yes	

#### Programming Notes

Note #	Description
unnumbered	Vector-Enhancements Facility 2



## ASMA Instruction Status

### Vector Integer Instructions – Chapter 22

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
VSLD	22-25	unnumbered	VRID1	yes	
VSRD	22-26	unnumbered	VRID1	yes	

#### Programming Notes

Note #	Description
unnumbered	Vector-Enhancements Facility 2

### Vector String Instructions – Chapter 23

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
VSTRS	23-8	2	VRRD	yes	

#### Programming Notes

Note #	Description
2	Vector-Enhancements Facility 2

### Vector Floating Point Instructions – Chapter 24

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
VCFPS	24-15	unnumbered	VRRA	yes	Rename VCDG
VCFPL	24-17	unnumbered	VRRA	yes	Rename VCDLG
VCSFP	24-18	unnumbered	VRRA	yes	Rename VCGD
VCLFP	24-20	unnumbered	VRRA	yes	Rename VCLDG

#### Programming Notes

Note #	Description
unnumbered	Vector-Enhancements Facility 2

## SA22-7832-13 – May, 2022

### Control Instructions – Chapter 10

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
LBEAR	10-51	13	S0 (zero)	yes	
LPSWEY	10-57	13	SIY0 (zero)	yes	
QPACI	10-123	15	S0 (zero)	yes	
RDP	10-124	14	RRFB2	yes	
STBEAR	10-145	13	S0 (zero)	yes	

#### Programming Notes

Note #	Description
13	BEAR-Enhancement Facility
14	Reset DAT-Protection Facility
15	Processor-Activity-Instrumentation Facility

### Vector Decimal Instructions – Chapter 25

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
VSCSHP	25-4	2	VRRRC	implemented	
VSCHP	25-5	2	VRRB	implemented	
VCSPH	25-11	2	VRRJ	implemented	
VCLZDP	25-11	2	VRRK	implemented	
VPKZR	25-18	2	VRIF	implemented	
VSRPR	25-26	2	VRIF	implemented	
VUPKZH	25-30	2	VRRK	implemented	
VUPKZL	25-31	2	VRRK	implemented	

#### Programming Notes

Note #	Description
2	Vector-Packed-Decimal-Enhancement Facility 2

### Specialized-Function-Assist Instructions – Chapter 26

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
KDSA	26-2	1	RRE	implemented	
DFLTCC	26-17	2	RRFA1	implemented	
NNPA	26-61	4	RRE1	implemented	
SORTL	26-96	3	RRE	implemented	
VCLFNH	26-121	4	VRR4	implemented	
VCLFNL	26-122	4	VRR4	implemented	
VCRNF	26-123	4	VRR4	implemented	

## ASMA Instruction Status

Mnemonic	Page #	Prog. Notes	MSL Format	Implemented	Notes
VCFN	26-123	4	VRRA4	implemented	
VCNF	26-124	4	VRRA4	implemented	

### Programming Notes

Note #	Description
1	Message-Security-Assist Extension 9
2	DEFLATE-Conversion Facility
3	Enhanced-Sort Facility
4	Neural-Network-Processing-Assist Facility

## Extended Mnemonics

This section documents the current status of extended mnemonics in ASMA. Support for the base machine instruction mnemonics are described in the preceding sections.

Refer to SA22-7832-13, Appendix J, for details. The following table only reflects the base mnemonic for which extended mnemonics are defined. Page numbers are for the -13 version.

All of the extended mnemonics requiring the MSL enhancements were defined by SA22-7832-04 or later versions and are *not* presently supported by ASMA.

All extended mnemonics up to and including ESA/390 either separate from z/Architecture or ESA/390 on a z/Architecture system *are* supported by ASMA. While ESA/390 continued to be available on z/Architecture until the release of the CZAM facility, ESA/390 ceased being enhanced on z/Architecture beyond PoO -02.

## General Instructions – Chapter 7

Base Mnemonic	Page #	MSL Format	Base ASMA Target	MSL	Notes
BCR	7-40		s360 (yes)		
BC	7-40		s360 (yes)		
BRAS	7-45		e390 (yes)		
BRC	7-46		e390 (yes)		
BRCT	7-47		e390 (yes)		
BRXH	7-48		e390 (yes)		
BRXLE	7-48		e390 (yes)		
BRASL	7-45		s390 (yes)		
BRCL	7-46		s390 (yes)		
BRASL	7-45		s390 (yes)		
BRCL	7-46		s390 (yes)		
BRCTG	7-47		s390x-00 (yes)		
BRCTH	7-47		s390x-00 (yes)		
BRXHG	7-48		s390x-00 (yes)		
BRXLG	7-48		s390x-00 (yes)		
IILF	7-266		s390x-04		
LLILF	7-284		s390x-04		
CRB	7-137		s390x-06		
CGRB	7-137		s390x-06		
CRJ	7-137		s390x-06		
CGRJ	7-137		s390x-06		
CRT	7-150		s390x-06		
CGRT	7-150		s390x-06		
CIB	7-137		s390x-06		
CGIB	7-137		s390x-06		

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Base Mnemonic	Page #	MSL Format	Base ASMA Target	MSL	Notes
CIJ	7-137		s390x-06		
CGIJ	7-137		s390x-06		
CIT	7-150		s390x-06		
CGIT	7-150		s390x-06		
CLRB	7-155		s390x-06		
CLGRB	7-155		s390x-06		
CLRJ	7-155		s390x-06		
CLGRJ	7-155		s390x-06		
CLRT	7-156		s390x-06		
CLGRT	7-156		s390x-06		
CLIB	7-155		s390x-06		
CLGIB	7-155		s390x-06		
CLIJ	7-155		s390x-06		
CLGIJ	7-155		s390x-06		
CLFIT	7-157		s390x-06		
CLGIT	7-157		s390x-06		
RNSBG	7-372		s390x-06		
<b>RNSBGT</b>	7-373		s390x-06		Treat this base as an extended mnemonic
RXSGB	7-372		s390x-06		
RISBG	7-374		s390x-06		
ROSBG	7-372		s390x-06		
BRCTH	7-47		s390x-08		
LOCR	7-287		s390x-08		
LOCGR	7-287		s390x-08		
LOC	7-287		s390x-08		
LOG	7-287		s390x-08		
CLT	7-156		s390x-08		
RISBHG	7-374		s390x-08		
<b>RISBHGZ</b>	7-375		s390x-08		Treat this base as an extended mnemonic
RISBLG	7-375		s390x-08		
<b>RISBLGZ</b>	7-375		s390x-08		Treat this base as an extended mnemonic
STOC	7-397		s390x-08		
STOCG	7-397		s390x-08		
CLGT	7-156		s390x-09		
RISBGN	7-374		s390x-09		
LOCHHI	7-280		s390x-10		
LOCHI	7-280		s390x-10		
LOGGHI	7-280		s390x-10		
LOCFHR	7-287		s390x-10		
LOCFH	7-287		s390x-10		
STOCFH	7-397		s390x-10		
BIC	7-39		s390x-11		
NORK	7-314		s390x-12		
NOGRK	7-314		s390x-12		
SELR	7-380		s390x-12		

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Base Mnemonic	Page #	MSL Format	Base ASMA Target	MSL	Notes
SELGR	7-380		s390x-12		
SELFHR	7-380		s390x-12		

### Appendix A – Extended Mnemonic Limitation

This appendix explains the current (2022) situation with regards to extended mnemonics and in general terms what enhancements are needed within MSL and where those enhancements affect the rest of ASMA.

Extended mnemonics when ASMA was under active development was limited to use of the mask field (bits 8-11) in various branch-type instructions. At the same time, there were a few instructions that utilized some or all of bits 8-15 for an extended operation field. Extended operation fields are used for operation codes in excess of eight bits. This influenced the design of the Machine Specification Language (MSL). MSL was from the start created to support an extended operation field, referred to as the XOP field in MSL formats.

Lacking multi-year imagination, the implementation decision was made to overload the XOP field as the implied mask for extended mnemonics. XOP at the time was a good decision. The contents of the XOP field is part of the instruction definition, not the format. So an extended mnemonic does, while requiring a specific format for the source fields in the assembly, can be shared with all instructions using bits 8-11 for the mask.

In this paradigm, an instruction can define bits in 8-11, or 8-15 as part of an extended mnemonic (the BC mask field) or an extended operation code (SAMx instructions), but not both.

Fast forward a decade and a half and ASMA is faced with a different situation. For one, an instruction may have an extended operation code field in bits other than 8-15. As it turns out MSL from the beginning supported that structure. However, some instructions now have extended mnemonics that use bits 8-11 for a mask **and** an extended operation code. The BIC instruction is a case in point. The overloading of the function of XOP precludes definition of extended mnemonics for this instruction.

Additionally, for a number of complex instructions, fields outside of bits 8-11 are used for the extended mnemonic. MSL has no way to describe what is to be placed in those extended mnemonic fields. It is this enhancement that is required of the MSL for these new extended mnemonics.

This enhancement touches three main portions of ASMA:

- MSL itself (doc/asma/MSL.odt and doc/asma/MSL.pdf), the
- MSL database built by ASMA at program start (asma/msldb.py), and the
- instruction builder (asma/insnbldr.py) to fill the extended mnemonic fields for the instruction.

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The database creation is really conversion of the MSL text files into Python constructs. `msldb.py` is essentially the syntax analyzer of the MSL. The Python constructs are passed to the instruction builder to fill in the values of the instruction fields. It identifies the source of for the machine instruction. In the context of a language, `insnbuilder.py` performs semantic processing of MSL.

Two MSL statements participate in instruction definition: the

- `inst` statement, and the
- `format` statement.

`inst` defines which format is used by the instruction and machine instruction constant content, such as the operation code or extended operation code.

`format` maps the instruction's source operands to the destination field within the machine instruction into which the operand value is inserted.

A new extended mnemonic format is required for those instructions that have extended mnemonics. This is because the instruction's source syntax changes as a result of the extended mnemonic.

However, the values used by each instruction in the extended mnemonic is instruction specific and should appear within the individual extended mnemonic's `inst` statement, as is the case for the XOP field content currently supported by MSL.

Additionally, certain extended mnemonics effect specific bits in certain ways, and some bits should be ignored. A mechanism for support of these individual cases require addition to MSL. An example is the ROTATE THEN... instructions. Others may appear. In the general case a special routine within ASMA must be triggered by the MSL to handle these cases.

It should be noted that a number of MSL parameters as they appear in the text file and are placed within the database are tightly coupled with operand syntax parsing and the instruction builder. Arbitrary changes to source operand names or machine instruction fields should not be made.

Once these enhancements have been made, it will be possible to define the missing extended mnemonics within the MSL files and assemble them.

## Implementation and Testing Considerations

The above is written as though the MSL language can be enhanced separate from instruction definition and implementation by ASMA. The realities of implementation and testing is that, while MSL changes must precede instruction definition, testing can not occur without all three



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components being enhanced. Yes, `mslrpt.py` allows testing of the MSL language. However, instructions that utilize the MSL enhancements and that can then be successfully assembled (`insnbldr.py`) is the real test. Those tests may result in changes to the MSL language or adjustments to `msldb.py` or `insnbldr.py` to achieve successful assembly.

In as much as the BIC instruction's extended mnemonics are already defined, testing will probably proceed with these extended mnemonics.