

SPIR-V Machine-readable Grammar

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Chapter 1. Introduction

This document defines the schema used by the machine-readable JSON grammar file for SPIR-V. This document is **not** the SPIR-V specification fully defining SPIR-V itself.

1.1. Goals and Conventions

- The machine-readable JSON grammar primarily aims to describe the syntax of various SPIR-V instructions. Semantics and validation rules remain in the human-readable SPIR-V specification.
- If a grammar struct has no particular attribute, e.g., `OpNop` has no operands and requires no additional capabilities, the corresponding key for that attribute in the JSON object is excluded for terseness.
- Keys in various JSON objects are in the `snake_case` format, while values are in the `CamelCase` format.
- `Operand kinds` of a specific `category` tend to have the category name as the prefix.

1.2. Alias mechanism

`Instructions`, `BitEnum operand kinds` and `ValueEnum operand kind` can have aliases. An alias is introduced when an instruction or operand kind from an extension is reused in another extension or is integrated into the core specifications without a change in semantics. As the semantics do not change from the original extension, the new extension or core specifications will reuse the same opcode or value but change the name for consistency. This leads to instructions or operand kinds sharing the same value but having different names.

Previous versions of the grammar dealt with this by duplicating the entry. This led to multiple entries sharing the same opcode or value, adding complexity for tooling.

New versions of the grammar now bans the duplication of the opcode or operand kind in favor of the `aliases` field to keep track of the name evolution.

Chapter 2. Top Level Structure

The whole JSON grammar file consists of a single JSON object containing the following key-value pairs:

```
{
  "copyright" : [ ... ],
  "magic_number" : "...",
  "major_version" : ...,
  "minor_version" : ...,
  "revision" : ...,
  "instructions" : [ ... ],
  "operand_kinds" : [ ... ]
}
```

magic_number

A string. The magic number for a SPIR-V module in the hexadecimal format.

major_version

An integer. The major version of the SPIR-V represented in this grammar file.

minor_version

An integer. The minor version of the SPIR-V represented in this grammar file.

revision

An integer. The revision of the SPIR-V represented in this grammar file.

instructions

A list of objects. Each object contains information about a specific instruction in the SPIR-V specification, including its name, opcode, required capabilities, layout of operands. The order of these objects dictates nothing. See the [JSON Objects for Instructions](#) Section for more details.

operand_kinds

A list of objects. Each object contains information about a specific operand kind, including its name, category, possible values, required capabilities, used in the operand layouts of [instructions](#). See the [JSON Objects for Operand Kinds](#) Section for more details.

Chapter 3. Grammar Objects

3.1. JSON objects for instructions

This kind of JSON object contains the information about a specific SPIR-V instruction. It has the following key-value pairs:

```
{
  "opname" : "...",
  "opcode" : ...,
  "operands" : [
    { "kind" : "...", quantifier : "...", name : "..." },
    { "kind" : "...", quantifier : "...", name : "..." },
    ...
  ],
  "capabilities" : [ ... ]
}
```

opname

A string. The name of this instruction, starting with **Op**. Must be unique in all **opname** in **instructions**.

opcode

An integer. The opcode enumerant for this instruction. Must be unique in all **opcode** in **instructions**.

operands

A list of objects. *Optional*. Each object contains the information about a logical operand for this instruction:

kind

A string. The **kind** of this operand.

quantifier

A string. *Optional*. If this key is missing, it means this operand should appear exactly once. Otherwise, the value can only be "?" or "*". If the value is "?", it means this operand appears zero or one time. If the value is "*", it means this operand appears zero or more times.

name

A string. *Optional*. A short descriptive name for this operand.

capabilities

A list of strings. *Optional*. If this field exists, each string is the name of a required **capability** for this instruction.

aliases

A list of strings. *Optional*. If this field exists, each string is an alternative name for this instruction. Each name must appear exactly once and must not be equal to **opname**.

3.2. Operand categories

Operand kinds are grouped into categories according to their possible values. Right now, there are only five categories:

BitEnum

For an operand kind belonging to this category, its value is a mask, which is formed by combining the bits specified as enumerants in an enum. See the [BitEnum Operand Kind](#) Section for more details.

ValueEnum

For an operand kind belonging to this category, its value is an enumerant from an enum. See the [ValueEnum Operand Kind](#) Section for more details.

Id

For an operand kind belonging to this category, its value is an <id> definition or reference.

Literal

For an operand kind belonging to this category, its value is a literal number or string.

Composite

For an operand kind belonging to this category, its value is composed from operand values from the above categories. See the [Composite Operand Kind](#) Section for more details.

3.3. JSON objects for operand kinds

This kind of JSON object contains the information about a specific operand kind. It has the following key-value pairs:

```
{
  "category" : "...",
  "kind" : "...",
  "doc" : "...",
  ...
}
```

category

A string. The [category](#) of this operand kind.

kind

A string. The name of this operand kind. Must be unique in all [kind](#) in [operand_kinds](#).

doc

A string. *Optional*. The human-readable definition of this operand kind.

Depending on the category of this operand kind, there may be more key-value pairs as explained in the following subsections.

3.3.1. The BitEnum operand kind

Apart from the general key-value pairs, this kind of JSON object additionally has:

```

{
  ...,
  "enumerants": [
    {
      "enumerant" : "...",
      "value" : "...",
      "capabilities" : [ ... ],
      "parameters" : [
        { "kind" : "..." },
        ...
      ]
    }
  ]
}

```

enumerants

A list of objects. Each object describes a possible bitflag for this operand kind:

enumerant

A string. The name of this bitflag. Must be unique in all **enumerant** in the **operand kind object**.

value

A string. The hexadecimal bit value of this bitflag. Must be unique in all **value** in the **operand kind object**.

capabilities

A list of strings. *Optional*. If this field exists, each string is the name of a required **capability** for this bitflag.

parameters

A list of objects. *Optional*. Each object describes a logical parameter for this bitflag:

kind

A string. The **kind** of this operand.

aliases

A list of strings. *Optional*. If this field exists, each string is an alternative name for this bitflag. Each name must appear exactly once and must not be equal to **enumerant**.

3.3.2. The ValueEnum operand kind

Apart from the general key-value pairs, this kind of JSON object additionally has:

```

{
  ...,
  "enumerants": [
    {
      "enumerant" : "...",
      "value" : ...,
      "capabilities" : [ ... ],

```



```

    "parameters" : [
      { "kind" : "..." },
      ...
    ]
  }
}

```

enumerants

A list of objects. Each object describes an possible enumerator for this operand kind:

enumerator

A string. The name of this enumerator. Must be unique in all **enumerator** in the **operand kind object**.

value

An integer. The value of this enumerator. Must be unique in all **value** in the **operand kind object**.

capabilities

A list of strings. *Optional*. If this field exists, each string is the name of a required **capability** for this enumerator.

extensions

A list of strings. *Optional*. The names of extensions that enable this feature. If absent, the feature is always enabled.

parameters

A list of objects. *Optional*. Each object describes a logical parameter for this enumerator:

kind

A string. The **kind** of this operand.

aliases

A list of strings. *Optional*. If this field exists, each string is an alternative name for this enumerator. Each name must appear exactly once and must not be equal to **enumerator**.

The Capability operand kind

For example, capabilities are represented as a **ValueEnum** operand kind:

```

{
  "category" : "ValueEnum",
  "kind" : "Capability",
  "enumerants" : [
    {
      "enumerator" : "Matrix",
      "value" : 0
    },
    {
      "enumerator" : "Shader",
      "value" : 1,
      "capabilities" : [ "Matrix" ]
    }
  ]
}

```

```

    },
    {
      "enumerant" : "Geometry",
      "value" : 2,
      "capabilities" : [ "Shader" ]
    },
    {
      "enumerant" : "Tessellation",
      "value" : 3,
      "capabilities" : [ "Shader" ]
    },
    {
      "enumerant" : "Addresses",
      "value" : 4
    },
    ...
  }

```

3.3.3. The Id operand kind

This kind of JSON object has no additional key-value pairs. All the kinds in this category are prefixed with **Id**.

3.3.4. The Literal operand kind

This kind of JSON object has no additional key-value pairs. All the kinds in this category are prefixed with **Literal**.

3.3.5. The Composite operand kind

This kind of JSON object additionally contains:

```

{
  ...,
  bases: [ ... ]
}

```

bases

A list of strings. Each string names an operand kind forming this **Composite** kind.

When an operand is of the **Composite** kind, all the operands listed in its **bases** must appear in the concrete case, in the given order.

Right now there are only three kinds defined in this category:

- **PairIdRefIdRef**: used by **OpPhi**.
- **PairLiteralIntegerIdRef**: used by **OpSwitch**.
- **PairIdRefLiteralInteger**: used by **OpGroupMemberDecorate**.

Chapter 4. Example Usage

Please see the [SPIRV-Tools](#) project for an example of how this grammar can be used.