



## **SPIR-V Machine-readable Grammar**

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# Contents

|          |  |          |
|----------|--|----------|
| <b>1</b> | <b>Introduction</b>                      | <b>4</b> |
| 1.1      | Goals and Conventions . . . . .          | 4        |
| <b>2</b> | <b>Top Level Structure</b>               | <b>4</b> |
| <b>3</b> | <b>Grammar Objects</b>                   | <b>5</b> |
| 3.1      | JSON objects for instructions . . . . .  | 5        |
| 3.2      | Operand categories . . . . .             | 5        |
| 3.3      | JSON objects for operand kinds . . . . . | 6        |
| 3.3.1    | The BitEnum operand kind . . . . .       | 6        |
| 3.3.2    | The ValueEnum operand kind . . . . .     | 7        |
|          | The Capability operand kind . . . . .    | 7        |
| 3.3.3    | The Id operand kind . . . . .            | 8        |
| 3.3.4    | The Literal operand kind . . . . .       | 8        |
| 3.3.5    | The Composite operand kind . . . . .     | 8        |
| <b>4</b> | <b>Example Usage</b>                     | <b>8</b> |

# 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.

## 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.

## 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.

#### **opcode**

An integer. The opcode enumerant for this instruction.

#### **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 existing, each string is the name of a required [capability](#) for this instruction.

### 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.

#### **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.

##### **value**

A string. The hexadecimal bit value of this bitflag.

##### **capabilities**

A list of strings. *Optional*. If existing, 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.

### 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 enumerant for this operand kind:

##### **enumerant**

A string. The name of this enumerant.

##### **value**

An integer. The value of this enumerant.

##### **capabilities**

A list of strings. *Optional*. If existing, each string is the name of a required [capability](#) for this enumerant.

##### **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 enumerant:

##### **kind**

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

### The Capability operand kind

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

```
{
  "category" : "ValueEnum",
  "kind" : "Capability",
  "enumerants" : [
    {
      "enumerant" : "Matrix",
      "value" : 0
    },
    {
      "enumerant" : "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`.

## 4 Example Usage

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