Comprehensive Minecraft Bedrock Block Development Guide for Cursor AI

This comprehensive guide contains detailed information from 250+ sources specifically designed to assist AI coding assistants like Cursor in creating professional-quality Minecraft Bedrock blocks. The guide covers everything from basic block structure to advanced Script API integration, custom components, block states, permutations, and advanced visual systems.

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1. Block Architecture & Core Concepts

What are Blocks?

Blocks are the fundamental building units in Minecraft Bedrock Edition that make up the world [215] [216]. They consist of server-side logic defined in behavior pack JSON files and visual assets defined in resource pack files.

Block File Structure

Behavior Pack Structure

```
behavior_pack/
├── manifest.json                    # Pack metadata
├── blocks/                          # Block behavior definitions
│   └── custom_block.json           # Main block logic
├── loot_tables/                     # Block drops &amp;amp; rewards
│   └── blocks/
│       └── custom_block.json       # Loot configuration
└── scripts/                         # Script API files
    └── main.js                      # Custom behaviors
```

Resource Pack Structure

```
resource_pack/
├── manifest.json                   # Pack metadata
├── textures/
│   ├── blocks/                     # Block textures
│   │   └── custom_block.png        # Block texture
│   └── terrain_texture.json        # Texture mapping
├── models/
│   └── blocks/
│       └── custom_block.geo.json   # 3D geometry (optional)
└── texts/
    └── en_US.lang                  # Block names
```

Minimum Block Definition [^215]

The simplest custom block requires this basic structure:

```
{
  "format_version": "1.21.110",
  "minecraft:block": {
    "description": {
      "identifier": "wiki:custom_block",
      "menu_category": {
        "category": "construction",
        "group": "minecraft:itemGroup.name.concrete",
        "is_hidden_in_commands": false
      }
    },
    "components": {}
  }
}
```

Block Description [^215]

- `identifier`: Unique ID in format `namespace:identifier`
- `menu_category`: Creative inventory placement
- `group`: Expandable group within category (optional)
- `is_hidden_in_commands`: Command visibility (optional)

2. Block Components Complete Reference

Based on Microsoft's official documentation [^223] and community wiki [^220], there are **30+ block components** available:

Essential Components

Core Block Components:

```
{
  "minecraft:display_name": "tile.wiki:custom_block.name",
  "minecraft:map_color": [255, 0, 0],
  "minecraft:friction": 0.6,
  "minecraft:light_emission": 15,
  "minecraft:light_dampening": 0
}
```

Collision & Selection

Collision Box Component [^220]:

```
{
  "minecraft:collision_box": {
    "origin": [-8, 0, -8],
    "size": [16, 16, 16]
  }
}
```

Selection Box Component [^220]:

```
{
  "minecraft:selection_box": {
    "origin": [-8, 0, -8],
    "size": [16, 16, 16]
  }
}
```

Destruction System

Destructible by Mining [^220]:

```
{
  "minecraft:destructible_by_mining": {
    "seconds_to_destroy": 20
  }
}
```

Destructible by Explosion [^220]:

```
{
  "minecraft:destructible_by_explosion": {
    "explosion_resistance": 20
  }
}
```

Loot Component [^220]:

```
{
  "minecraft:loot": "loot_tables/blocks/custom_block.json"
}
```

Visual & Geometry Components

Geometry Component [[219]][220]:

```
{
  "minecraft:geometry": {
    "identifier": "geometry.custom_block",
    "culling": "wiki:culling.custom_block",
    "bone_visibility": {
      "conditional_bone": "q.block_state('wiki:state') == 3"
    }
  }
}
```

Material Instances [[232]][220]:

```
{
  "minecraft:material_instances": {
    "*": {
      "texture": "custom_block_texture",
      "render_method": "alpha_test",
      "ambient_occlusion": true,
```

```
      "face_dimming": true
    },
    "up": {
      "texture": "custom_block_top"
    },
    "down": {
      "texture": "custom_block_bottom"
    }
  }
}
```

Available Render Methods:

- `opaque`: Standard solid blocks (stone, dirt)
- `alpha_test`: Transparent areas (ladder, vines)
- `alpha_test_single_sided`: One-sided transparency (doors, saplings)
- `blend`: Translucent blocks (glass, honey)
- `double_sided`: No backface culling (powder snow)

Interactive Components

Crafting Table Component [^220]:

```
{
  "minecraft:crafting_table": {
    "table_name": "Wiki Workbench",
    "crafting_tags": [
      "crafting_table",
      "wiki:workbench"
    ]
  }
}
```

Environmental Components

Flammable Component [^220]:

```
{
  "minecraft:flammable": {
    "catch_chance_modifier": 5,
    "destroy_chance_modifier": 20
  }
}
```

Liquid Detection [^220]:

```
{
  "minecraft:liquid_detection": {
    "detection_rules": [
      {
        "liquid_type": "water",
        "can_contain_liquid": true,
        "on_liquid_touches": "no_reaction"
      }
    ]
  }
}
```

Advanced Components

Placement Filter [^220]:

```
{
  "minecraft:placement_filter": {
    "conditions": [
      {
        "allowed_faces": ["up"],
        "block_filter": [
          "minecraft:dirt",
          {
            "name": "minecraft:sand",
            "states": {
              "sand_type": "red"
            }
          }
        ]
      }
    ]
  }
}
```

Transformation Component [^220]:

```
{
  "minecraft:transformation": {
    "translation": [-5, 8, 0],
    "rotation": [90, 180, 0],
    "rotation_pivot": [0, 0, 0],
    "scale": [0.5, 1, 0.5],
    "scale_pivot": [0, 0, 0]
  }
}
```

Tick Component [^220]:

```
{
  "minecraft:tick": {
    "interval_range": [10, 20],
    "looping": true
  }
}
```

Redstone Components

Redstone Conductivity [^220]:

```
{
  "minecraft:redstone_conductivity": {
    "redstone_conductor": true,
    "allows_wire_to_step_down": false
  }
}
```

Redstone Producer [^220]:

```
{
  "minecraft:redstone_producer": {
    "power": 15,
    "strongly_powered_face": "north",
    "transform_relative": true
  }
}
```

Utility Components

Random Offset [^220]:

```
{
  "minecraft:random_offset": {
    "x": {
      "steps": 0,
      "range": {
        "min": -8,
        "max": 8
      }
    },
    "y": {
      "steps": 3,
      "range": {
        "min": -2,
        "max": 0
```

```
      }
    }
  }
}
```

3. Block States & Permutations

Block States System [^230]

Block states allow blocks to have variants with different functionality and appearance:

Defining States [^230]:

```
{
  "format_version": "1.21.110",
  "minecraft:block": {
    "description": {
      "identifier": "wiki:custom_block",
      "states": {
        "wiki:string_state_example": ["red", "green", "blue"],
        "wiki:boolean_state_example": [false, true],
        "wiki:integer_state_example": [1, 2, 3],
        "wiki:integer_range_state_example": {
          "values": { "min": 0, "max": 5 }
        }
      }
    },
    "components": {},
    "permutations": []
  }
}
```

State Limitations:

- Maximum 16 valid values per state
- Integer range: max value cannot be more than 15 higher than min value
- Maximum 65,536 permutations per block

Getting State Values

Molang Query Function [^230]:

```
q.block_state('wiki:string_state_example') == 'blue'
```

Command Argument [^230]:

```
execute if block ~~~ wiki:custom_block["wiki:string_state_example"="blue", "wiki:integer_
```

Script API [^230]:

```
customBlock.permutation.getState("wiki:integer_state_example") === 3;
```

Setting State Values

Commands [^230]:

```
setblock ~~~ wiki:custom_block["wiki:string_state_example"="blue", "wiki:integer_state_ex
```

Script API [^230]:

```
customBlock.setPermutation(
  customBlock.permutation.withState("wiki:boolean_state_example", false)
);
```

Block Permutations [^134]

Permutations allow conditional component application based on block states:

Conditional Components [^134]:

```
{
  "permutations": [
    {
      "condition": "q.block_state('wiki:integer_state_example') == 2",
      "components": {
        "minecraft:friction": 0.1
      }
    },
    {
      "condition": "q.block_state('wiki:boolean_state_example')",
      "components": {
        "minecraft:friction": 0.8
      }
    },
    {
      "condition": "q.block_state('wiki:string_state_example') == 'red' &amp;amp;&amp;amp; !q.blo
      "components": {
        "minecraft:geometry": "geometry.pig"
      }
    }
```

```
  ]
}
```

Permutation Calculation: Multiply the number of valid values for each state together

- Example: 2 boolean states = 2 × 2 = 4 permutations

4. Script API Integration & Custom Components

BlockCustomComponent Interface [^235]

The Script API provides comprehensive block event handling:

Complete Event Interface:

```
/** @type {import("@minecraft/server").BlockCustomComponent} */
const CompleteBlockComponent = {
    beforeOnPlayerPlace(event) {
        // Runs before block placement, can cancel
        // event.cancel = true to prevent placement
    },

    onPlace(event) {
        // Runs when block is placed
        // event.block, event.dimension, event.previousBlock
    },

    onPlayerBreak(event) {
        // Runs when player breaks the block
        // event.block, event.brokenBlockPermutation, event.player
    },

    onPlayerInteract(event) {
        // Runs when player right-clicks/interacts
        // event.block, event.face, event.faceLocation, event.player
    },

    onStepOn(event) {
        // Runs when entity steps on block (requires collision_box Y &gt;= 4)
        // event.block, event.entity
    },

    onStepOff(event) {
        // Runs when entity steps off block
        // event.block, event.entity
    },

    onEntityFallOn(event) {
        // Runs when entity falls on block (requires entity_fall_on component)
        // event.block, event.entity, event.fallDistance
    },
```

```
    onTick(event) {
        // Runs on timed intervals (requires tick component)
        // event.block, event.dimension
    },

    onRandomTick(event) {
        // Runs on random ticks like crop growth
        // event.block, event.dimension
    }
};
```

Custom Component Registration [^235]

Components must be registered before world loads:

```
import { system } from "@minecraft/server";

system.beforeEvents.startup.subscribe(({ blockComponentRegistry }) =&gt; {
    blockComponentRegistry.registerCustomComponent(
        "wiki:interactive_block",
        CompleteBlockComponent
    );
});
```

Advanced Custom Component Examples

Teleporter Block:

```
/** @type {import("@minecraft/server").BlockCustomComponent} */
const TeleporterComponent = {
    onPlayerInteract(event) {
        const player = event.player;
        if (!player) return;

        // Teleport player 10 blocks up
        const newLocation = {
            x: player.location.x,
            y: player.location.y + 10,
            z: player.location.z
        };

        player.tryTeleport(newLocation);
        player.playSound("mob.enderman.portal");

        // Add particles
        event.dimension.spawnParticle("minecraft:portal_particle",
            player.location);
    },

    onStepOn(event) {
        const entity = event.entity;
        if (entity &amp;&amp; entity.typeId === "minecraft:player") {
```

```
            entity.addEffect("minecraft:speed", 200, { amplifier: 2 });
        }
    }
};
```

Growth Accelerator Block:

```
/** @type {import("@minecraft/server").BlockCustomComponent} */
const GrowthAcceleratorComponent = {
    onTick(event) {
        const block = event.block;
        const dimension = event.dimension;

        // Check blocks above for crops
        for (let y = 1; y &lt;= 3; y++) {
            const checkLocation = {
                x: block.location.x,
                y: block.location.y + y,
                z: block.location.z
            };

            const targetBlock = dimension.getBlock(checkLocation);
            if (targetBlock) {
                const states = targetBlock.permutation.getAllStates();

                // Accelerate crop growth
                if (states.growth !== undefined &amp;&amp; states.growth &lt; 7) {
                    const newGrowth = Math.min(7, states.growth + 1);
                    targetBlock.setPermutation(
                        targetBlock.permutation.withState("growth", newGrowth)
                    );

                    // Growth particles
                    dimension.spawnParticle("minecraft:crop_growth_emitter",
                        targetBlock.location);
                }
            }
        }
    }
};
```

Conditional Placement Block:

```
/** @type {import("@minecraft/server").BlockCustomComponent} */
const ConditionalPlacementComponent = {
    beforeOnPlayerPlace(event) {
        const player = event.player;
        if (!player) return;

        // Only allow placement in creative mode
        if (player.getGameMode() !== GameMode.Creative) {
            event.cancel = true;
            player.sendMessage("§cThis block can only be placed in Creative mode!");
```

```
            return;
        }

        // Check if player has permission (using tags)
        if (!player.hasTag("builder")) {
            event.cancel = true;
            player.sendMessage("§cYou need builder permission to place this block!");
            return;
        }
    }
};
```

JSON Component Integration [^235]

Custom components are added directly to block components:

```
{
  "minecraft:block": {
    "description": {
      "identifier": "wiki:teleporter_block"
    },
    "components": {
      "wiki:teleporter": {},
      "minecraft:collision_box": {
        "origin": [-8, 0, -8],
        "size": [16, 4, 16]
      },
      "minecraft:light_emission": 10,
      "minecraft:material_instances": {
        "*": {
          "texture": "teleporter_block",
          "render_method": "blend"
        }
      }
    }
  }
}
```

5. Block Events & Event Handling

Complete Block Events System [^239]

Block events provide comprehensive interaction handling:

Event Types & Parameters:

1. beforeOnPlayerPlace - Prevention event

```
beforeOnPlayerPlace(event) {
    // event.block - Block being replaced
```

```
    // event.cancel - Set to true to prevent placement
    // event.dimension - Dimension containing block
    // event.face - Face being placed on
    // event.permutationToPlace - Can modify placed permutation
    // event.player - Placing player (may be undefined)
}
```

2. onPlace - Post-placement event

```
onPlace(event) {
    // event.block - Newly placed block
    // event.dimension - Dimension containing block
    // event.previousBlock - Block that was replaced
}
```

3. onPlayerBreak - Block destruction

```
onPlayerBreak(event) {
    // event.block - Block after breaking (usually air)
    // event.brokenBlockPermutation - Original block before break
    // event.dimension - Dimension containing block
    // event.player - Breaking player (may be undefined)
}
```

4. onPlayerInteract - Right-click interaction

```
onPlayerInteract(event) {
    // event.block - Interacted block
    // event.dimension - Dimension containing block
    // event.face - Face that was clicked
    // event.faceLocation - Exact click location on face
    // event.player - Interacting player (may be undefined)
}
```

5. onStepOn/onStepOff - Entity stepping

```
onStepOn(event) {
    // event.block - Block being stepped on
    // event.dimension - Dimension containing block
    // event.entity - Stepping entity (may be undefined)
}
// Requires minecraft:collision_box with Y &gt;= 4
```

6. onEntityFallOn - Fall damage events

```
onEntityFallOn(event) {
    // event.block - Block fallen onto
    // event.dimension - Dimension containing block
    // event.entity - Falling entity
    // event.fallDistance - Distance fallen
```

```
}
// Requires minecraft:entity_fall_on component
```

7. onTick - Scheduled execution

```
onTick(event) {
    // event.block - Ticking block
    // event.dimension - Dimension containing block
}
// Requires minecraft:tick component
```

8. onRandomTick - Random execution

```
onRandomTick(event) {
    // event.block - Randomly ticked block
    // event.dimension - Dimension containing block
}
// Natural random tick system
```

Advanced Event Examples

Multi-State Interactive Block:

```
/** @type {import("@minecraft/server").BlockCustomComponent} */
const MultiStateComponent = {
    onPlayerInteract(event) {
        const block = event.block;
        const player = event.player;

        // Get current state
        const currentState = block.permutation.getState("wiki:interaction_count") || 0;
        const newState = (currentState + 1) % 4; // Cycle through 0-3

        // Update block state
        block.setPermutation(
            block.permutation.withState("wiki:interaction_count", newState)
        );

        // Different effects per state
        switch (newState) {
            case 0:
                player?.sendMessage("§aState: Inactive");
                break;
            case 1:
                player?.sendMessage("§eState: Charging");
                event.dimension.spawnParticle("minecraft:villager_happy",
                    block.location);
                break;
            case 2:
                player?.sendMessage("§6State: Active");
                event.dimension.spawnParticle("minecraft:critical_hit_emitter",
```

```
                    block.location);
                break;
            case 3:
                player?.sendMessage("§cState: Overloaded");
                event.dimension.spawnParticle("minecraft:lava_particle",
                    block.location);
                break;
        }
    }
};
```

Proximity Detector Block:

```
/** @type {import("@minecraft/server").BlockCustomComponent} */
const ProximityDetectorComponent = {
    onTick(event) {
        const block = event.block;
        const dimension = event.dimension;

        // Check for players within 5 block radius
        const nearbyEntities = dimension.getEntitiesAtBlockLocation(block.location);
        const nearbyPlayers = dimension.getPlayers({
            location: block.location,
            maxDistance: 5,
            minDistance: 0
        });

        const currentState = block.permutation.getState("wiki:detected") || false;
        const shouldDetect = nearbyPlayers.length &gt; 0;

        if (shouldDetect !== currentState) {
            // Update detection state
            block.setPermutation(
                block.permutation.withState("wiki:detected", shouldDetect)
            );

            if (shouldDetect) {
                // Player detected - activate
                dimension.runCommand(`setblock ${block.location.x} ${block.location.y + 1
            } else {
                // No players - deactivate
                dimension.runCommand(`setblock ${block.location.x} ${block.location.y + 1
            }
        }
    }
};
```

6. Geometry & Custom Models

Block Geometry System [219][222]

Custom block geometry allows creating non-cube blocks:

Geometry Limitations:

- Block limited to 30×30×30 pixels
- At least 1 pixel on each axis must be within standard 16×16×16 unit
- Absolute bounds: 30 pixels in each direction from origin

Blockbench Integration [^222]

Block Creation Workflow:

1. **Install Block Wizard Plugin** in Blockbench
2. **Create New Project** → Minecraft Block Wizard
3. **Design Geometry** with proper UV mapping
4. **Export to Resource Pack** as geometry file
5. **Link in Behavior Pack** via geometry component

Basic Geometry Component:

```
{
  "minecraft:geometry": "geometry.custom_block"
}
```

Advanced Geometry Component [^220]:

```
{
  "minecraft:geometry": {
    "identifier": "geometry.custom_block",
    "culling": "wiki:culling.custom_block",
    "bone_visibility": {
      "main_body": true,
      "decoration": "q.block_state('wiki:decorated') == true",
      "damage_overlay": "q.block_state('wiki:damage') &gt; 5"
    },
    "uv_lock": ["main_bone", "rotating_part"]
  }
}
```

Custom Block Model Examples

Sushi Block Example [^222]:

```
{
  "minecraft:geometry": "geometry.sushi",
  "minecraft:material_instances": {
    "north": {
      "texture": "salmon_roll"
    },
    "south": {
      "texture": "salmon_roll"
    },
    "*": {
      "texture": "sushi_wrap"
    }
  }
}
```

Lamp Block with Conditional Geometry:

```
{
  "minecraft:geometry": {
    "identifier": "geometry.lamp",
    "bone_visibility": {
      "lamp_shade": true,
      "light_bulb": "q.block_state('wiki:is_on') == true",
      "broken_glass": "q.block_state('wiki:is_broken') == true"
    }
  }
}
```

Item Visual Component [^220]

Controls how blocks appear as items:

```
{
  "minecraft:item_visual": {
    "geometry": "geometry.custom_item_display",
    "material_instances": {
      "*": {
        "texture": "custom_block_item_texture"
      }
    }
  }
}
```

7. Material Instances & Texturing

Material Instance System [232][220]

Material instances control block rendering and textures:

Complete Material Instance Configuration:

```
{
  "minecraft:material_instances": {
    "*": {
      "texture": "default_texture",
      "render_method": "opaque",
      "ambient_occlusion": true,
      "face_dimming": true,
      "isotropic": false
    },
    "up": {
      "texture": "top_texture"
    },
    "down": {
      "texture": "bottom_texture"
    },
    "north": {
      "texture": "side_texture"
    },
    "south": "north",
    "east": "north",
    "west": "north",
    "custom_face": {
      "texture": "special_texture",
      "render_method": "alpha_test",
      "tint_method": "grass"
    }
  }
}
```

Render Methods [^220]

Standard Render Methods:

- `opaque` (default): Solid blocks, no transparency
- `alpha_test`: Sharp transparency (ladders, spawners)
- `alpha_test_single_sided`: One-sided transparency (doors, trapdoors)
- `blend`: Smooth transparency (glass, honey blocks)
- `double_sided`: No backface culling (powder snow)

Distance-Based Render Methods:

- `alpha_test_to_opaque`: Alpha test near, opaque far (leaves)
- `alpha_test_single_sided_to_opaque`: Single-sided near, opaque far (kelp)
- `blend_to_opaque`: Blend near, opaque far

Advanced Texturing Features

Tint Methods [^220]:

```
{
  "texture": "grass_block_top",
  "tint_method": "grass"
}
```

Available Tint Methods:

- `grass` - Biome grass coloring
- `foliage` - Biome foliage coloring
- `water` - Biome water coloring
- `default_foliage` - Default foliage tinting

Ambient Occlusion Control:

```
{
  "ambient_occlusion": 0.8,  // Float value 0.0-10.0
  "face_dimming": false      // Disable directional dimming
}
```

Texture Atlas Integration

Terrain Texture Definition:

```
{
  "resource_pack_name": "Custom Blocks Pack",
  "texture_name": "atlas.terrain",
  "padding": 8,
  "num_mip_levels": 4,
  "texture_data": {
    "custom_block_texture": {
      "textures": "textures/blocks/custom_block"
    },
    "animated_block": {
      "textures": [
        "textures/blocks/animated_frame_0",
        "textures/blocks/animated_frame_1",
        "textures/blocks/animated_frame_2"
```

```
      ]
    }
  }
}
```

8. Block Placement & Filters

Placement Filter System [^220]

Control where and how blocks can be placed:

Basic Placement Requirements:

```
{
  "minecraft:placement_filter": {
    "conditions": [
      {
        "allowed_faces": ["up"],
        "block_filter": [
          "minecraft:dirt",
          "minecraft:grass_block"
        ]
      }
    ]
  }
}
```

Advanced Placement Conditions:

```
{
  "minecraft:placement_filter": {
    "conditions": [
      {
        "allowed_faces": ["up", "side"],
        "block_filter": [
          {
            "name": "minecraft:sand",
            "states": {
              "sand_type": "red"
            }
          },
          {
            "tags": "q.any_tag('minecraft:dirt_like', 'wiki:fertile')"
          }
        ]
      },
      {
        "allowed_faces": ["down"],
        "block_filter": [
          {
            "tags": "!q.any_tag('minecraft:liquid')"
```

```
          }
        ]
      }
    ]
  }
}
```

Block Survival & Pop-off

Auto-Destruction System:

```
{
  "minecraft:placement_filter": {
    "conditions": [
      {
        "allowed_faces": ["up"],
        "block_filter": ["minecraft:grass_block"]
      }
    ]
  }
}
```

When conditions aren't met:

- Block automatically pops off as item
- Prevents invalid block states
- Maintains world integrity

Replaceable Blocks [^220]

Allow blocks to be replaced when placing other blocks:

```
{
  "minecraft:replaceable": {}
}
```

Examples: Grass, flowers, water (can be replaced by solid blocks)

9. Redstone & Electrical Systems

Redstone Conductivity [^220]

Control redstone signal transmission:

Basic Redstone Conductor:

```
{
  "minecraft:redstone_conductivity": {
    "redstone_conductor": true,
    "allows_wire_to_step_down": true
  }
}
```

Advanced Redstone Properties:

```
{
  "minecraft:redstone_conductivity": {
    "redstone_conductor": false,     // Doesn't conduct power
    "allows_wire_to_step_down": false // Wire can't step down from this block
  }
}
```

Redstone Producer [^220]

Generate redstone signals:

Power Source Block:

```
{
  "minecraft:redstone_producer": {
    "power": 15,                    // Signal strength (0-15)
    "strongly_powered_face": "up",  // Strong power direction
    "connected_faces": ["up", "north", "south"], // Which faces output power
    "transform_relative": true      // Rotate with block orientation
  }
}
```

Advanced Redstone Integration

State-Based Power Output:

```
{
  "permutations": [
    {
      "condition": "q.block_state('wiki:power_level') == 0",
      "components": {
        "minecraft:redstone_producer": {
          "power": 0
        }
      }
    },
    {
      "condition": "q.block_state('wiki:power_level') == 1",
```

```
      "components": {
        "minecraft:redstone_producer": {
          "power": 5
        }
      }
    },
    {
      "condition": "q.block_state('wiki:power_level') == 2",
      "components": {
        "minecraft:redstone_producer": {
          "power": 10
        }
      }
    },
    {
      "condition": "q.block_state('wiki:power_level') == 3",
      "components": {
        "minecraft:redstone_producer": {
          "power": 15
        }
      }
    }
  ]
}
```

Redstone-Controlled Block Script:

```
/** @type {import("@minecraft/server").BlockCustomComponent} */
const RedstoneControlledComponent = {
    onTick(event) {
        const block = event.block;
        const dimension = event.dimension;

        // Check if receiving redstone power
        const isPowered = block.isValid() &amp;amp;&amp;amp; this.checkRedstonePower(block, dimer
        const currentState = block.permutation.getState("wiki:powered") || false;

        if (isPowered !== currentState) {
            block.setPermutation(
                block.permutation.withState("wiki:powered", isPowered)
            );
        }
    },

    checkRedstonePower(block, dimension) {
        // Check adjacent blocks for redstone power
        const adjacentOffsets = [
            { x: 1, y: 0, z: 0 },
            { x: -1, y: 0, z: 0 },
            { x: 0, y: 1, z: 0 },
            { x: 0, y: -1, z: 0 },
            { x: 0, y: 0, z: 1 },
            { x: 0, y: 0, z: -1 }
        ];
```

```
        for (const offset of adjacentOffsets) {
            const checkLocation = {
                x: block.location.x + offset.x,
                y: block.location.y + offset.y,
                z: block.location.z + offset.z
            };

            const adjacentBlock = dimension.getBlock(checkLocation);
            if (adjacentBlock?.hasTag("redstone_power_source")) {
                return true;
            }
        }

        return false;
    }
};
```

10. Advanced Block Features

Entity Interaction Systems

Entity Fall On Component [^220]:

```
{
  "minecraft:entity_fall_on": {
    "min_fall_distance": 3
  }
}
```

Combined with custom component:

```
/** @type {import("@minecraft/server").BlockCustomComponent} */
const BouncePadComponent = {
    onEntityFallOn(event) {
        const entity = event.entity;
        const fallDistance = event.fallDistance;

        if (entity &amp;&amp; fallDistance &gt; 3) {
            // Bounce effect
            entity.addEffect("minecraft:jump_boost", 100, { amplifier: 5 });
            entity.addEffect("minecraft:slow_falling", 60);

            // Launch upward
            entity.applyKnockback(0, 0, 0, 2.0); // Upward velocity

            // Visual effects
            event.dimension.spawnParticle("minecraft:critical_hit_emitter",
                event.block.location);

            // Sound effect
            entity.playSound("random.orb");
```

```
        }
    }
};
```

Flower Pot Integration [^220]

Allow blocks to be placed in flower pots:

```
{
  "minecraft:flower_pottable": {},
  "minecraft:embedded_visual": {
    "geometry": "geometry.potted_version",
    "material_instances": {
      "*": {
        "texture": "custom_plant_texture"
      }
    }
  }
}
```

Destruction Particles [^220]

Custom particle effects when blocks are destroyed:

```
{
  "minecraft:destruction_particles": {
    "particle_count": 150,
    "texture": "custom_particle_texture",
    "tint_method": "grass"
  }
}
```

Advanced Transformation Effects

Rotating Block System:

```
{
  "states": {
    "wiki:rotation": [0, 1, 2, 3]
  },
  "permutations": [
    {
      "condition": "q.block_state('wiki:rotation') == 0",
      "components": {
        "minecraft:transformation": {
          "rotation": [0, 0, 0]
        }
      }
    },
    {
```

```
      "condition": "q.block_state('wiki:rotation') == 1",
      "components": {
        "minecraft:transformation": {
          "rotation": [0, 90, 0]
        }
      }
    },
    {
      "condition": "q.block_state('wiki:rotation') == 2",
      "components": {
        "minecraft:transformation": {
          "rotation": [0, 180, 0]
        }
      }
    },
    {
      "condition": "q.block_state('wiki:rotation') == 3",
      "components": {
        "minecraft:transformation": {
          "rotation": [0, 270, 0]
        }
      }
    }
  ]
}
```

With placement script:

```
/** @type {import("@minecraft/server").BlockCustomComponent} */
const AutoRotateComponent = {
    beforeOnPlayerPlace(event) {
        const player = event.player;
        if (!player) return;

        // Calculate rotation based on player facing
        const viewDirection = player.getViewDirection();
        let rotation = 0;

        if (Math.abs(viewDirection.x) &gt; Math.abs(viewDirection.z)) {
            rotation = viewDirection.x &gt; 0 ? 1 : 3; // East : West
        } else {
            rotation = viewDirection.z &gt; 0 ? 2 : 0; // South : North
        }

        // Set the rotation state
        event.permutationToPlace = event.permutationToPlace.withState("wiki:rotation", ro
    }
};
```

Multi-Block Structures

Structure Formation Script:

```
/** @type {import("@minecraft/server").BlockCustomComponent} */
const MultiBlockComponent = {
    onPlace(event) {
        const block = event.block;
        const dimension = event.dimension;

        // Check if this completes a 3x3 structure
        if (this.checkStructureComplete(block, dimension)) {
            this.activateStructure(block, dimension);
        }
    },

    checkStructureComplete(centerBlock, dimension) {
        const center = centerBlock.location;

        // Check 3x3 pattern
        for (let x = -1; x &lt;= 1; x++) {
            for (let z = -1; z &lt;= 1; z++) {
                const checkLocation = {
                    x: center.x + x,
                    y: center.y,
                    z: center.z + z
                };

                const block = dimension.getBlock(checkLocation);
                if (block?.typeId !== "wiki:structure_block") {
                    return false;
                }
            }
        }

        return true;
    },

    activateStructure(centerBlock, dimension) {
        const center = centerBlock.location;

        // Transform structure blocks
        for (let x = -1; x &lt;= 1; x++) {
            for (let z = -1; z &lt;= 1; z++) {
                const targetLocation = {
                    x: center.x + x,
                    y: center.y,
                    z: center.z + z
                };

                const block = dimension.getBlock(targetLocation);
                if (block) {
                    block.setPermutation(
                        block.permutation.withState("wiki:activated", true)
                    );
```

```
                }
            }
        }

        // Spawn structure entity or activate effect
        dimension.spawnEntity("wiki:structure_guardian", {
            x: center.x,
            y: center.y + 2,
            z: center.z
        });
    }
};
```

11. Blockbench Integration

Block Wizard Plugin [^228]

Blockbench provides the Block Wizard plugin for easy block creation:

Installation & Setup:

1. Open Blockbench
2. File → Plugins
3. Install "Minecraft Block Wizard"
4. New → Loaders → Minecraft Block Wizard

Block Creation Process:

1. **Define Block Properties**:
   - Name and identifier
   - Block type preset
   - Base properties
2. **Design Geometry**:
   - Create custom shapes
   - Set UV coordinates
   - Apply textures
3. **Configure Materials**:
   - Set render methods
   - Configure transparency
   - Apply face-specific textures
4. **Export Files**:
   - Geometry (.geo.json)

- Texture files
- Block definition templates

Custom Geometry Guidelines

Block Geometry Constraints:

- Maximum 30×30×30 pixels total size
- Must have at least 1 pixel within 16×16×16 standard unit
- Absolute position bounds: ±30 pixels from origin
- Can be positioned anywhere within these constraints

UV Mapping Best Practices:

- Use consistent texture resolution (16×16 recommended)
- Align UV coordinates to pixel boundaries
- Consider texture atlas limitations
- Test with different render methods

Advanced Blockbench Features

Bone Visibility Control:

```
{
  "minecraft:geometry": {
    "identifier": "geometry.complex_block",
    "bone_visibility": {
      "base_structure": true,
      "detail_layer": "q.block_state('wiki:detailed') == true",
      "damage_cracks": "q.block_state('wiki:damage') &gt; 0",
      "seasonal_decoration": "q.block_state('wiki:season') == 'winter'"
    }
  }
}
```

Animation Integration:

```
{
  "format_version": "1.8.0",
  "animations": {
    "animation.spinning_block.rotate": {
      "loop": true,
      "animation_length": 4.0,
      "bones": {
        "main_body": {
          "rotation": {
```

```
            "0.0": [0, 0, 0],
            "4.0": [0, 360, 0]
          }
        }
      }
    }
  }
}
```

12. Troubleshooting & Best Practices

Common Issues & Solutions

Block Not Appearing

1. **Check identifiers** - BP and RP must match exactly
2. **Verify manifest.json** - Ensure correct format versions
3. **Check file paths** - Blocks go in `blocks/` folder
4. **Clear cache** - Delete behavior pack cache folders

Texture Not Loading

1. **Check terrain_texture.json** - Verify texture mapping
2. **File format** - Use PNG format only
3. **File paths** - Ensure textures are in correct folders
4. **Naming** - Avoid spaces and special characters

Custom Geometry Issues

1. **Size limits** - Check 30×30×30 pixel constraint
2. **Unit bounds** - Ensure 1 pixel within 16×16×16 unit
3. **Culling problems** - Use proper culling definitions
4. **UV coordinates** - Verify texture mapping accuracy

Script Components Not Working

1. **Registration timing** - Register before world loads
2. **Manifest dependencies** - Include Script API modules
3. **Format versions** - Use compatible versions
4. **Component names** - Must match exactly between JSON and script

Performance Optimization

Permutation Limits:

- Maximum 65,536 permutations per block
- Maximum 65,536 custom permutations per world
- Calculate: multiply state values (2×2×4 = 16 permutations)

Script Optimization:

```
// Throttle expensive operations
const blockCache = new Map();

/** @type {import("@minecraft/server").BlockCustomComponent} */
const OptimizedComponent = {
    onTick(event) {
        const blockId = `${event.block.location.x}_${event.block.location.y}_${event.bloc
        const lastUpdate = blockCache.get(blockId) || 0;
        const currentTime = Date.now();

        // Only run expensive operations every 5 seconds
        if (currentTime - lastUpdate &gt; 5000) {
            blockCache.set(blockId, currentTime);

            // Expensive operations here
            this.performExpensiveCalculation(event);
        }
    }
};
```

Geometry Optimization:

- Minimize bone count
- Use efficient UV layouts
- Optimize texture sizes
- Reduce complexity where possible

Development Best Practices

1. **Use Consistent Naming**: Always use namespaces and consistent naming
2. **Test Incrementally**: Test each component individually
3. **Document Components**: Comment your custom components
4. **Version Control**: Use appropriate format versions
5. **Error Handling**: Always handle Script API errors
6. **Performance**: Avoid expensive operations in frequent events

Content Log Analysis

Monitor content logs for:

- Permutation count warnings
- Geometry constraint violations
- Script API errors
- Component conflicts
- Resource loading failures

13. Complete Code Examples

Complete Interactive Block Example

Behavior Pack Block (`blocks/magic_altar.json`)

```
{
  "format_version": "1.21.110",
  "minecraft:block": {
    "description": {
      "identifier": "wiki:magic_altar",
      "menu_category": {
        "category": "equipment"
      },
      "states": {
        "wiki:power_level": [0, 1, 2, 3],
        "wiki:activated": [false, true],
        "wiki:has_crystal": [false, true]
      }
    },
    "components": {
      "minecraft:geometry": {
        "identifier": "geometry.magic_altar",
        "bone_visibility": {
          "crystal": "q.block_state('wiki:has_crystal')",
          "power_glow": "q.block_state('wiki:power_level') &gt; 0"
        }
      },
      "minecraft:material_instances": {
        "*": {
          "texture": "magic_altar_base",
          "render_method": "alpha_test"
        },
        "crystal": {
          "texture": "magic_crystal",
          "render_method": "blend"
        }
      },
      "minecraft:collision_box": {
        "origin": [-8, 0, -8],
```

```
        "size": [16, 12, 16]
      },
      "minecraft:selection_box": {
        "origin": [-8, 0, -8],
        "size": [16, 12, 16]
      },
      "minecraft:destructible_by_mining": {
        "seconds_to_destroy": 15
      },
      "minecraft:destructible_by_explosion": {
        "explosion_resistance": 30
      },
      "minecraft:tick": {
        "interval_range": [20, 40],
        "looping": true
      },
      "wiki:magic_altar": {},
      "wiki:power_manager": {}
    },
    "permutations": [
      {
        "condition": "q.block_state('wiki:activated')",
        "components": {
          "minecraft:light_emission": 10,
          "minecraft:material_instances": {
            "*": {
              "texture": "magic_altar_active",
              "render_method": "blend"
            }
          }
        }
      },
      {
        "condition": "q.block_state('wiki:power_level') &gt;= 3",
        "components": {
          "minecraft:light_emission": 15,
          "minecraft:redstone_producer": {
            "power": 15,
            "strongly_powered_face": "up"
          }
        }
      }
    ]
  }
}
```

Script Component (`scripts/magic_altar.js`)

```
import { world, system, ItemStack, BlockPermutation, GameMode } from "@minecraft/server";

/** @type {import("@minecraft/server").BlockCustomComponent} */
const MagicAltarComponent = {
    onPlayerInteract(event) {
        const { block, player, face } = event;
        if (!player) return;
```

```
        const inventory = player.getComponent("minecraft:inventory");
        const selectedItem = inventory.container.getItem(player.selectedSlotIndex);

        const hasCrystal = block.permutation.getState("wiki:has_crystal");
        const powerLevel = block.permutation.getState("wiki:power_level") || 0;

        // Place crystal
        if (selectedItem?.typeId === "minecraft:amethyst_shard" &amp;&amp; !hasCrystal) {
            block.setPermutation(
                block.permutation.withState("wiki:has_crystal", true)
            );

            // Consume item (unless creative)
            if (player.getGameMode() !== GameMode.Creative) {
                selectedItem.amount--;
                if (selectedItem.amount &lt;= 0) {
                    inventory.container.setItem(player.selectedSlotIndex);
                } else {
                    inventory.container.setItem(player.selectedSlotIndex, selectedItem);
                }
            }

            player.sendMessage("§bCrystal placed on altar");
            this.playAltarSound(event.dimension, block.location, "block.amethyst_block.pl

        } else if (selectedItem?.typeId === "minecraft:glowstone_dust" &amp;&amp; hasCrys
            // Power up altar
            const newPowerLevel = Math.min(3, powerLevel + 1);
            block.setPermutation(
                block.permutation
                    .withState("wiki:power_level", newPowerLevel)
                    .withState("wiki:activated", newPowerLevel &gt; 0)
            );

            // Consume dust
            if (player.getGameMode() !== GameMode.Creative) {
                selectedItem.amount--;
                if (selectedItem.amount &lt;= 0) {
                    inventory.container.setItem(player.selectedSlotIndex);
                } else {
                    inventory.container.setItem(player.selectedSlotIndex, selectedItem);
                }
            }

            player.sendMessage(`§6Altar power: ${newPowerLevel}/3`);
            this.playAltarSound(event.dimension, block.location, "random.orb");

        } else if (!selectedItem &amp;&amp; hasCrystal) {
            // Remove crystal
            block.setPermutation(
                block.permutation
                    .withState("wiki:has_crystal", false)
                    .withState("wiki:power_level", 0)
                    .withState("wiki:activated", false)
            );
```

```
        // Drop crystal
        const crystal = new ItemStack("minecraft:amethyst_shard", 1);
        event.dimension.spawnItem(crystal, {
            x: block.location.x + 0.5,
            y: block.location.y + 1,
            z: block.location.z + 0.5
        });

        player.sendMessage("§7Crystal removed");
    }
},

onTick(event) {
    const { block, dimension } = event;
    const powerLevel = block.permutation.getState("wiki:power_level") || 0;
    const activated = block.permutation.getState("wiki:activated") || false;

    if (activated &amp;amp;&amp;amp; powerLevel &gt; 0) {
        // Particle effects
        this.spawnMagicParticles(dimension, block.location, powerLevel);

        // Check for nearby players to grant effects
        const nearbyPlayers = dimension.getPlayers({
            location: block.location,
            maxDistance: 5
        });

        for (const player of nearbyPlayers) {
            // Grant effects based on power level
            if (powerLevel &gt;= 1) {
                player.addEffect("minecraft:regeneration", 60, { amplifier: 0 });
            }
            if (powerLevel &gt;= 2) {
                player.addEffect("minecraft:speed", 60, { amplifier: 0 });
            }
            if (powerLevel &gt;= 3) {
                player.addEffect("minecraft:night_vision", 220);
            }
        }
    }
},

onPlayerBreak(event) {
    const { block, dimension } = event;
    const hasCrystal = block.permutation.getState("wiki:has_crystal");

    if (hasCrystal) {
        // Drop crystal when altar is broken
        const crystal = new ItemStack("minecraft:amethyst_shard", 1);
        dimension.spawnItem(crystal, {
            x: block.location.x + 0.5,
            y: block.location.y + 0.5,
            z: block.location.z + 0.5
        });
    }
```

```
    },

    playAltarSound(dimension, location, sound) {
        dimension.runCommand(`playsound ${sound} @a[r=10] ${location.x} ${location.y} ${l
    },

    spawnMagicParticles(dimension, location, powerLevel) {
        const particleTypes = [
            "minecraft:villager_happy",
            "minecraft:critical_hit_emitter",
            "minecraft:dragon_breath_particle"
        ];

        const particleType = particleTypes[Math.min(powerLevel - 1, 2)];

        // Spawn particles in circle around altar
        for (let i = 0; i &lt; 8; i++) {
            const angle = (i / 8) * Math.PI * 2;
            const x = location.x + Math.cos(angle) * 2;
            const z = location.z + Math.sin(angle) * 2;
            const y = location.y + 1;

            dimension.spawnParticle(particleType, { x, y, z });
        }
    }
};

/** @type {import("@minecraft/server").BlockCustomComponent} */
const PowerManagerComponent = {
    onRandomTick(event) {
        const { block } = event;
        const powerLevel = block.permutation.getState("wiki:power_level") || 0;
        const activated = block.permutation.getState("wiki:activated") || false;

        // Slowly lose power over time
        if (activated &amp;&amp; powerLevel &gt; 0 &amp;&amp; Math.random() &lt; 0.1) {
            const newPowerLevel = powerLevel - 1;
            block.setPermutation(
                block.permutation
                    .withState("wiki:power_level", newPowerLevel)
                    .withState("wiki:activated", newPowerLevel &gt; 0)
            );
        }
    }
};

// Register components
system.beforeEvents.startup.subscribe(({ blockComponentRegistry }) =&gt; {
    blockComponentRegistry.registerCustomComponent("wiki:magic_altar", MagicAltarComponen
    blockComponentRegistry.registerCustomComponent("wiki:power_manager", PowerManagerComp
});
```

Resource Pack Texture Mapping (`textures/terrain_texture.json`)

```
{
  "resource_pack_name": "Magic Blocks Pack",
  "texture_name": "atlas.terrain",
  "padding": 8,
  "num_mip_levels": 4,
  "texture_data": {
    "magic_altar_base": {
      "textures": "textures/blocks/magic_altar_base"
    },
    "magic_altar_active": {
      "textures": "textures/blocks/magic_altar_active"
    },
    "magic_crystal": {
      "textures": "textures/blocks/magic_crystal"
    }
  }
}
```

Loot Table (`loot_tables/blocks/magic_altar.json`)

```
{
  "pools": [
    {
      "rolls": 1,
      "entries": [
        {
          "type": "item",
          "name": "wiki:magic_altar",
          "weight": 1
        }
      ]
    }
  ]
}
```

This comprehensive guide provides over 250 sources of information specifically designed for AI assistants to create professional-quality Minecraft Bedrock blocks. Each section includes practical examples, Script API integration, and troubleshooting information to ensure successful block development with full modern feature support.
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⁂

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