RPG Maker XP documentation

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August 24, 2020

Contents

1 What this document is about

This document holds information about how RPG Maker XP implements *Maps* and *Events*, which is relevant in project PoGER's map/feature extraction effort.

Please read this document's Privacy Policy.

As a result of the limited scope of PoGER and the limited time and information available to the author, the following documentation isn't complete and may not be accurate.

The information was obtained through the official RPG Maker XP built-in documentation, user content found on the internet (forum posts, videos) and the author's reverse-engineering work.

The following abbreviations may be present :

- **RMXP** - RPG Maker XP
- **PE** - Pokemon Essentials

Please note that the author is not a native English speaker.

1.1 Related documents

This is but one in a collection of manuscripts, each with its scope (*sorted older to newer*) :

- **Vision document** : A very early analysis about Pokemon Essentials, focused on identifying its issues and properties of a hypothetical software solution.
- **PoGER** : Gives information on the project itself, including motivations and objectives.
- ***RMXP doc*** : Contains the results of my research about RPG Maker XP's implementation of game data (mostly *Maps* and *Events*), with the objective to extract them to an interpretable format.
- **Extraction** : Contain a practical guide on the extraction process for anyone trying to reproduce it.

2 How RMXP stores data

A crucial first step in any reverse-engineering effort in data extraction is to understand used data structures.

As RMXP games run on a *Ruby interpreter*, every element we encounter is either of a *primitive type* or an *object* (class instance).

Ruby primitive types :

- Arrays
- Hashes
- Boolean
- Symbols
- Numbers
- Strings

For the task at end, let's focus on the classes that are associated with maps and events, most of which are part of the RMXP library (other are defined in PE scripts). *See RMXP_full.png*

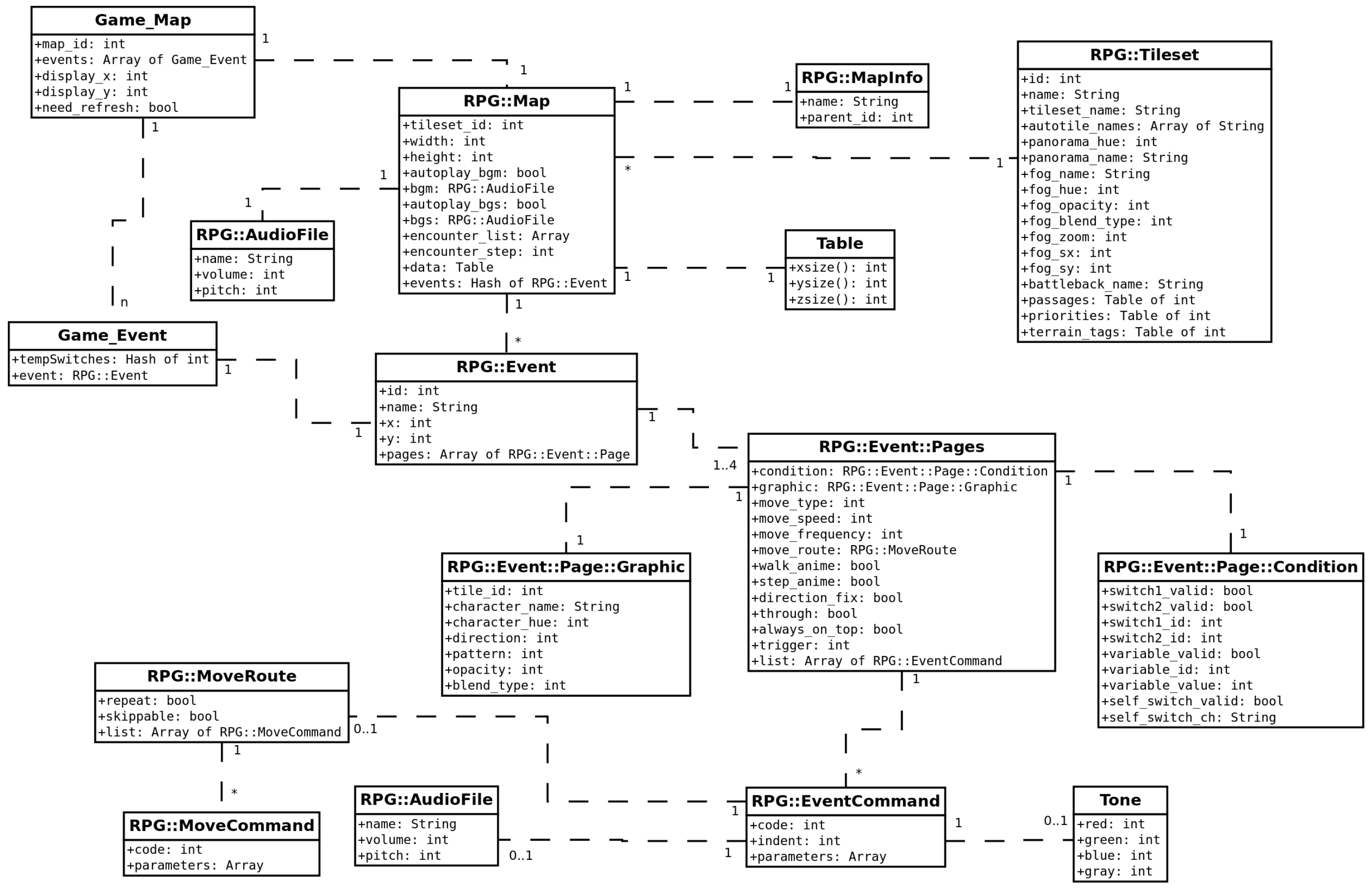


Figure 1: Simplified class map representation for Map/Event

Semantic/Syntax : Linked classes (with arity) display an **associative relationship**.

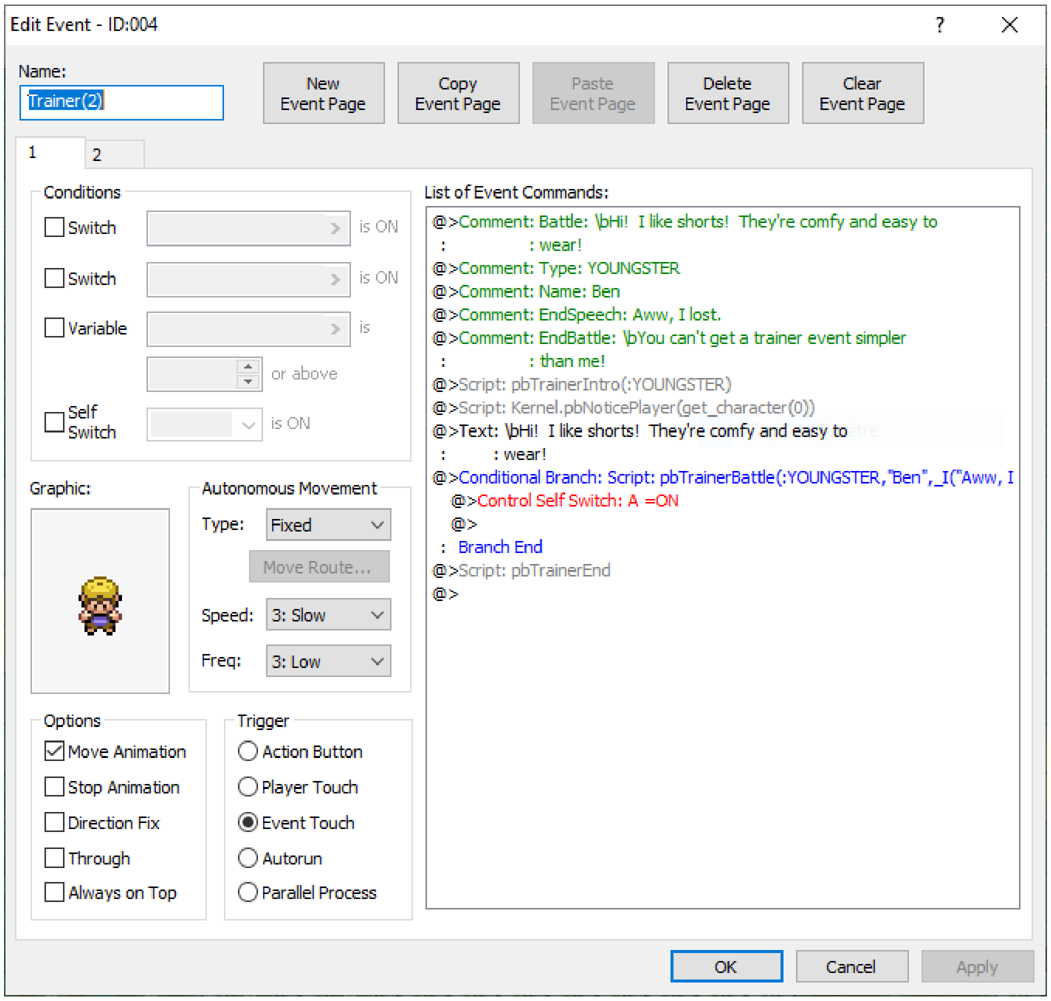
Note : There is no inheritance relationship between any two classes represented. Arities are logically deduced and may not be exact depending in proprietary implementation details. Class `RPG::AudioFile` was duplicated for ease of association routing.

3 Events

An event, or more precisely a *map event*, is a way to introduce elements with behavior, therefore bringing flexibility and dynamism into the game world.

Events have two aspects :

- A GUI element



Edit Event - ID:004

Name: Trainer(2)

Conditions
- [ ] Switch is ON
- [ ] Switch is ON
- [ ] Variable is
  or above
- [ ] Self Switch is ON

Graphic:

Autonomous Movement
Type: Fixed
Speed: 3: Slow
Freq: 3: Low

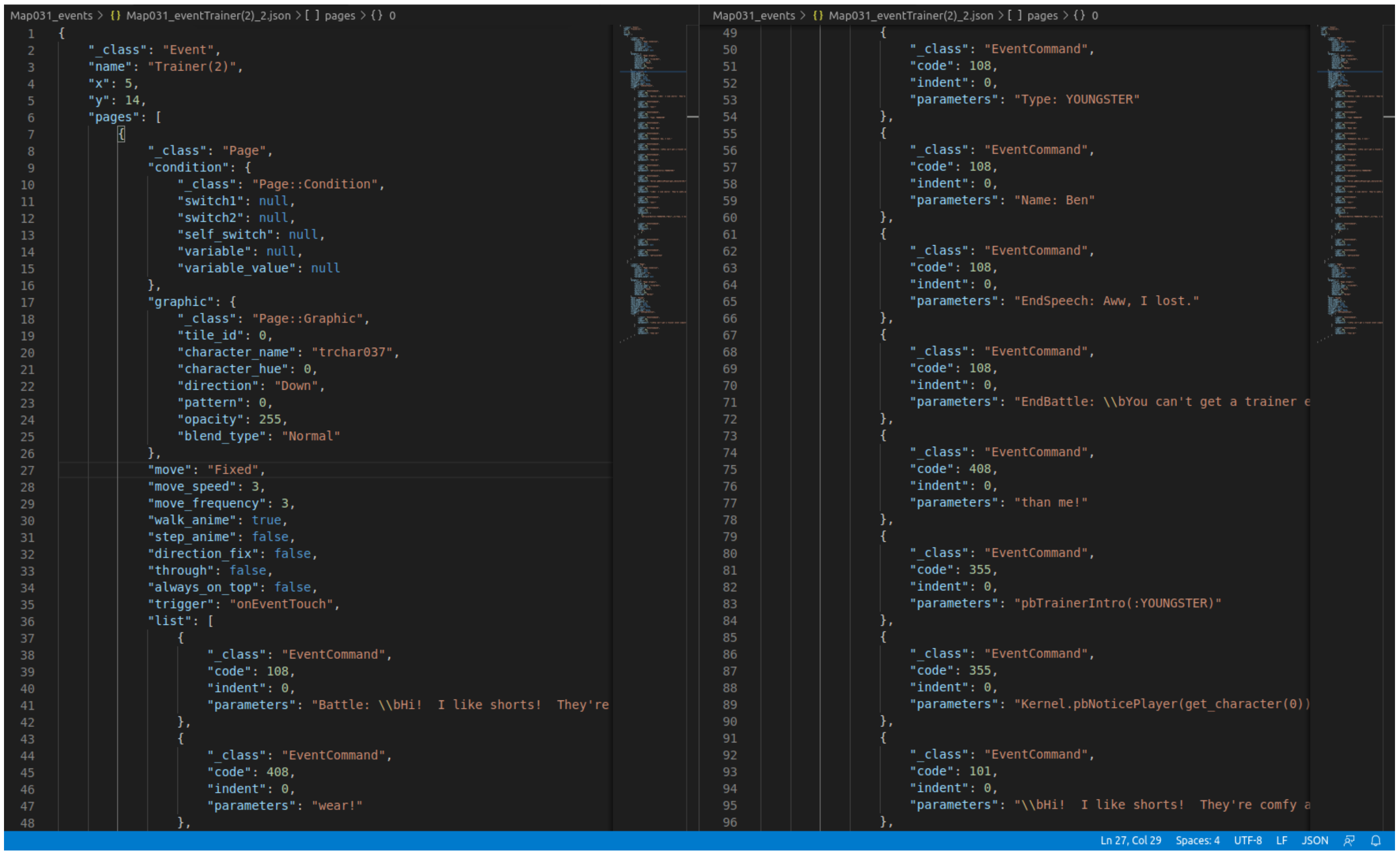
Options
- [✓] Move Animation
- [ ] Stop Animation
- [ ] Direction Fix
- [ ] Through
- [ ] Always on Top

Trigger
- ○ Action Button
- ○ Player Touch
- ● Event Touch
- ○ Autorun
- ○ Parallel Process

List of Event Commands:

```
@>Comment: Battle: \bHi!  I like shorts!  They're comfy and easy to
 :              : wear!
@>Comment: Type: YOUNGSTER
@>Comment: Name: Ben
@>Comment: EndSpeech: Aww, I lost.
@>Comment: EndBattle: \bYou can't get a trainer event simpler
 :              : than me!
@>Script: pbTrainerIntro(:YOUNGSTER)
@>Script: Kernel.pbNoticePlayer(get_character(0))
@>Text: \bHi!  I like shorts!  They're comfy and easy to
 :        : wear!
@>Conditional Branch: Script: pbTrainerBattle(:YOUNGSTER,"Ben",_I("Aww, I
  @>Control Self Switch: A =ON
  @>
 :  Branch End
@>Script: pbTrainerEnd
@>
```

- Its data class instance counterpart `RPG::Event`


Map031_events > {} Map031_eventTrainer(2)_2.json > [ ] pages > {} 0
Map031_events > {} Map031_eventTrainer(2)_2.json > [ ] pages > {} 0
Ln 27, Col 29 Spaces: 4 UTF-8 LF JSON

```
{
    "_class": "Event",
    "name": "Trainer(2)",
    "x": 5,
    "y": 14,
    "pages": [
        {
            "_class": "Page",
            "condition": {
                "_class": "Page::Condition",
                "switch1": null,
                "switch2": null,
                "self_switch": null,
                "variable": null,
                "variable_value": null
            },
            "graphic": {
                "_class": "Page::Graphic",
                "tile_id": 0,
                "character_name": "trchar037",
                "character_hue": 0,
                "direction": "Down",
                "pattern": 0,
                "opacity": 255,
                "blend_type": "Normal"
            },
            "move": "Fixed",
            "move_speed": 3,
            "move_frequency": 3,
            "walk_anime": true,
            "step_anime": false,
            "direction_fix": false,
            "through": false,
            "always_on_top": false,
            "trigger": "onEventTouch",
            "list": [
                {
                    "_class": "EventCommand",
                    "code": 108,
                    "indent": 0,
                    "parameters": "Battle: \\bHi!  I like shorts!  They're
                },
                {
                    "_class": "EventCommand",
                    "code": 408,
                    "indent": 0,
                    "parameters": "wear!"
                },
                {
                    "_class": "EventCommand",
                    "code": 108,
                    "indent": 0,
                    "parameters": "Type: YOUNGSTER"
                },
                {
                    "_class": "EventCommand",
                    "code": 108,
                    "indent": 0,
                    "parameters": "Name: Ben"
                },
                {
                    "_class": "EventCommand",
                    "code": 108,
                    "indent": 0,
                    "parameters": "EndSpeech: Aww, I lost."
                },
                {
                    "_class": "EventCommand",
                    "code": 108,
                    "indent": 0,
                    "parameters": "EndBattle: \\bYou can't get a trainer e
                },
                {
                    "_class": "EventCommand",
                    "code": 408,
                    "indent": 0,
                    "parameters": "than me!"
                },
                {
                    "_class": "EventCommand",
                    "code": 355,
                    "indent": 0,
                    "parameters": "pbTrainerIntro(:YOUNGSTER)"
                },
                {
                    "_class": "EventCommand",
                    "code": 355,
                    "indent": 0,
                    "parameters": "Kernel.pbNoticePlayer(get_character(0))
                },
                {
                    "_class": "EventCommand",
                    "code": 101,
                    "indent": 0,
                    "parameters": "\\bHi!  I like shorts!  They're comfy a
                },
```

3.1 Basic functionalities

These are the easiest and most straightforward behavior to implement into an event :

- Giving an element a *sprite* (texture) : This is useful for objects capable of movement, NPCs, etc.
- *Movement* : Select how the element moves with presets (speed, frequency, pattern, etc).
- *Event commands* : Select the trigger for behavior and what the element does when triggered (movement, dialogue, etc) within the extensive command list.

3.2 Advanced functionalities

These require an understanding of conditional execution and scripting :

- *Conditional execution* : branching instructions based on the value of : global variables, global switches, self switches, script return, etc.
- *Pages* : Allow to give an element different behavior depending on conditions.
- *Move routes* : Define a sequence of movement commands to be executed.
- *Script calls* : Call a script to be executed for more complex behavior, launching mini-games, retrieving data, etc.

4 Commands

Commands are a mechanism, through which most of an `RPG::Event`'s behavior is defined.

Although they are very similar in structure and use, a distinction is made between `RPG::EventCommand` and `RPG::MoveCommand`.

EventCommands are the representation of elements present in the "List of Event Commands" in the GUI. They are the building block of event's behavior.

MoveCommands are the representation of an individual movement the event is capable of, typically found in sequences `RPG::MoveRoute` associated with a dedicated *EventCommand*.

They both have, at least :

- A *code* : An integer that uniquely identifies the particular command.
- *Parameters* : Depend on the particular command, can be empty, a variable, an object, or a list of objects.

Additionally, *EventCommands* have an *indent* integer value, tied to the layout visible in the "List of Event Commands" in the GUI.

4.1 Methodology

In order to successfully *extract semantic from events*, it was decided that *documenting* every command used in Pokemon Essentials and finding an appropriate (human-readable) *representation* was the way forward.

The objective is to formalize a **DSL** (Domain Specific Language) into which events will be translated to, which exhibit desirable properties (See Command Representation decisions section.).

4.2 Miscellaneous information

Codes used in Pokemon Essentials 17.2 (*81 total*) :

> 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 33, 34, 37, 38, 39, 40, 41, 42, 44, 101, 102, 104, 106, 108, 111, 112, 113, 115, 118, 119, 121, 122, 123, 125, 201, 202, 208, 209, 210, 221, 222, 223, 225, 231, 232, 235, 236, 241, 242, 247, 248, 249, 250, 314, 354, 355, 401, 402, 404, 408, 411, 412, 413, 655

Implementation details :

- `RPG::MoveCommand` use range [1-45]
- `RPG::EventCommand` use range [101-x], $x \geq 655$
- A "frame" is defined as $\frac{1}{20}$ second $\Rightarrow$ change into milliseconds $m = n * 1000/20 \equiv n * 50$.
- Every event has an ID (integer > 0). Actions that can affect other events can target the player using id `-1` and the current event using id `0`.
- Special variables : MapID, PartyMembers, Gold, Steps, PlayTime, *Timer*, SaveCount.

  They should all be read accessible. Underlined ones should also be write accessible. *Italic ones are probably not used.*

4.3 List of commands

0	Description	Nothing, empty command or end of the event command list
	Parameters	None
	Notes	Will not be represented
1	Description	`RPG::MoveCommand` - Move to the South
	Parameters	None
	Notes	See footnote[1]
2	Description	`RPG::MoveCommand` - Move to the West
	Parameters	None
	Notes	See footnote[1]
3	Description	`RPG::MoveCommand` - Move to the East
	Parameters	None
	Notes	See footnote[1]
4	Description	`RPG::MoveCommand` - Move to the North
	Parameters	None
	Notes	See footnote[1]
5	Description	`RPG::MoveCommand` - Move to the SouthWest
	Parameters	None
	Notes	See footnote[1]
6	Description	`RPG::MoveCommand` - Move to the SouthEast
	Parameters	None
	Notes	See footnote[1]
7	Description	`RPG::MoveCommand` - Move to the NorthWest
	Parameters	None
	Notes	See footnote[1]
8	Description	`RPG::MoveCommand` - Move to the NorthEast
	Parameters	None
	Notes	See footnote[1]
9	Description	`RPG::MoveCommand` - Move at random (N,E,S,W)
	Parameters	None
	Notes	See footnote[1]
	Representation	”Move, R”
10	Description	`RPG::MoveCommand` - Move towards player
	Parameters	None
	Notes	See footnotes[1,3]
11	Description	`RPG::MoveCommand` - Move away from player
	Parameters	None
	Notes	See footnotes[1,3]
12	Description	`RPG::MoveCommand` - Take 1 step forward
	Parameters	None
	Notes	See footnote[1]

13	Description	`RPG::MoveCommand` - Take 1 step backward
	Parameters	None
	Notes	See footnote[1]
14	Description	`RPG::MoveCommand` - Jump to relative coordinates on the same map
	Parameters	[2] - **0**:deltaX `[signed integer]`, **1**:deltaY `[signed integer]`
	Notes	
15	Description	`RPG::MoveCommand` - Wait n seconds
	Parameters	[1] - **0**:number of seconds to wait n `[integer` $\in \mathbb{N}^*$`]`
	Notes	Typically $n == 2$, but values up to 15 were found in PE.
16	Description	`RPG::MoveCommand` - Turn towards South
	Parameters	None
	Notes	See footnote[2]
17	Description	`RPG::MoveCommand` - Turn towards West
	Parameters	None
	Notes	See footnote[2]
18	Description	`RPG::MoveCommand` - Turn towards East
	Parameters	None
	Notes	See footnote[2]
19	Description	`RPG::MoveCommand` - Turn towards North
	Parameters	None
	Notes	See footnote[2]
20	Description	`RPG::MoveCommand` - Turn 90° right, relative to current position
	Parameters	None
	Notes	See footnote[2]
21	Description	`RPG::MoveCommand` - Turn 90° left, relative to current position
	Parameters	None
	Notes	See footnote[2]
22	Description	`RPG::MoveCommand` - Turn 180°
	Parameters	None
	Notes	See footnote[2]
23	Description	`RPG::MoveCommand` - Turn 90° to the left or right, at random
	Parameters	None
	Notes	See footnote[2]
24	Description	`RPG::MoveCommand` - Turn at random (90° or 180°)
	Parameters	None
	Notes	See footnote[2]
25	Description	`RPG::MoveCommand` - Turn towards player
	Parameters	None
	Notes	See footnotes[2,3]
26	Description	`RPG::MoveCommand` - Turn away from player
	Parameters	None
	Notes	See footnotes[2,3]

33	Description	`RPG::MoveCommand` - Turn ON walking animation
	Parameters	None
	Notes	
34	Description	`RPG::MoveCommand` - Turn OFF walking animation
	Parameters	None
	Notes	
37	Description	`RPG::MoveCommand` - Turn ON ”through”
	Parameters	None
	Notes	Equivalent to activating ”walk through walls”, making it possible to walk through impassable tiles/characters.
38	Description	`RPG::MoveCommand` - Turn OFF ”through”
	Parameters	None
	Notes	Equivalent to deactivating ”walk through walls”.
39	Description	`RPG::MoveCommand` - Always on top ON
	Parameters	None
	Notes	Elevate the display priority, therefore bringing the event graphic to the forefront (above any tile/character)
40	Description	`RPG::MoveCommand` - Always on top OFF
	Parameters	None
	Notes	
41	Description	`RPG::MoveCommand` - Change event's graphic
	Parameters	[2] - **0**:texture file `[String]`, **1**:hue, **2**:direction d `[integer]`, **3**:step `[integer 0-3]`
	Notes	See note[5]. **0** without extension. **1** is unused.
42	Description	`RPG::MoveCommand` - Change event's graphic opacity
	Parameters	[1] - **0**:new opacity value n `[integer 0-255]`
	Notes	
44	Description	`RPG::MoveCommand` - Play a sound effect
	Parameters	TODO
	Notes	
101	Description	`RPG::EventCommand` - Show text
	Parameters	[1] - **0**:text s `[String]`
	Notes	s must be properly double-quoted and formatted (inner double-quotes and backslashes must be escaped).
401	Description	`RPG::EventCommand` - Show text (continued)
	Parameters	[1] - **0**:text s `[String]`
	Notes	Continuation of 101.
102	Description	`RPG::EventCommand` - Show choices
	Parameters	[2] - **0**:array of size n `[Array of Strings]`, **1**:cancel behaviour `[integer 0-4]`
	Notes	Displays up to 4 selectable options in a message window. Cancel behaviour : 0 disallow canceling, 1-4$\leq n$ selects choice by default.
104	Description	`RPG::EventCommand` - Change text options
	Parameters	[2] - **0**:position p `[integer 0-2]`, **1**:window border b `[integer 0-1]`
	Notes	Sets message window position and border. p follows ”common relation 1”, b follows ”common relation 2”
106	Description	`RPG::EventCommand` - Wait
	Parameters	[1] - **0**:number of frames to wait n `[integer` $\in \mathbb{N}^*$`]`
	Notes	Conversion to milliseconds chosen for its more precise and general use : $m = n * 1000/20 \equiv n * 50$, TODO:research its use

108	Description	`RPG::EventCommand` - Comment
	Parameters	[1] - **0**:comment text s `[String]`
	Notes	Has no effect. TODO:research link to particle effects.
408	Description	`RPG::EventCommand` - Comment (continued)
	Parameters	[1] - **0**:comment text s `[String]`
	Notes	Happens after a 108.
111	Description	`RPG::EventCommand` - Conditional branch
	Parameters	See "Conditional branch" section.
	Notes	Complex but essential command.
112	Description	`RPG::EventCommand` - Loop
	Parameters	None
	Notes	Loops over commands until broken. TODO:research usage
113	Description	`RPG::EventCommand` - Break loop
	Parameters	None
	Notes	Escape innermost loop. TODO:research usage
115	Description	`RPG::EventCommand` - Exit Event Processing
	Parameters	None
	Notes	TODO:research usage
118	Description	`RPG::EventCommand` - Label
	Parameters	[1] - **0**:label name s `[String]`
	Notes	Sets a label to allow jumping to.
119	Description	`RPG::EventCommand` - Jump to Label
	Parameters	[1] - **0**:label name s `[String]`
	Notes	Jumps to a label.
121	Description	`RPG::EventCommand` - Control switches
	Parameters	[3] - **0**:starting switch ssa `[integer]`, **0**:ending switch ssz `[integer]`, **0**:state n `[integer]`
	Notes	Batch control is unused in PE, therefore deprecated. n follows "common relation 3".
122	Description	`RPG::EventCommand` - Control variables
	Parameters	See "Control variables" section.
	Notes	Batch control is unused in PE, therefore deprecated.
123	Description	`RPG::EventCommand` - Control Self Switch
	Parameters	[2] - **0**:SS character s `[String of length 1]`, **1**:new state n `[integer 0-1]`
	Notes	n follows "common relation 3".
125	Description	`RPG::EventCommand` - Change Gold
	Parameters	[3] - **0**:operation o `[integer 0-1]`, **1**:operand n `[integer 0-1]`, **2**:value v `[integer]`
	Notes	Values of n: 0:v is a constant, 1:v is a variable(id). o follows "common relation 4"
201	Description	`RPG::EventCommand` - Transfer Player
	Parameters	[6] - **1**:map m `[integer]`, **2**:coordinate x `[integer]`, **3**:coordinate y `[integer]`, **4**:player direction d `[integer]`, **5**:fading f `[integer]`.
	Notes	{0} must be 0, 1 unused in PE. d follows "common relation 5". f follows "common relation 3".

202	Description	`RPG::EventCommand` - Set Event Location
	Parameters	[5] - **0**:event id e `[integer]`, **2**:coordinate x `[integer]`, **3**:coordinate y `[integer]`, **4**:direction d `[integer]`
	Notes	Change an event's location on the current map. {1} must be 0, other values unused in PE. d follows "common relation 5".
208	Description	`RPG::EventCommand` - Change Transparency Flag
	Parameters	[2] - **0**:flag d `[integer 0-1]`
	Notes	When transparency is set, the graphic isn't displayed. d follows "common relation 3".
209	Description	`RPG::EventCommand` - Set Move Route
	Parameters	[2] - **0**:target id d `[integer]`, **1**:`RPG::MoveRoute`
	Notes	
210	Description	`RPG::EventCommand` - Wait for Move's Completion
	Parameters	None
	Notes	To be put after a Set Move Route. Without it, further commands can be executed before the end of the walking animation.
221	Description	`RPG::EventCommand` - Prepare for transition
	Parameters	None
	Notes	Freezes the screen, so there's nothing moving during the transition. To be fused with Execute Transition.
222	Description	`RPG::EventCommand` - Execute Transition
	Parameters	[1] - **0**:transition file name s `[String]`
	Notes	Plays the animation. TODO:research how transition work.
223	Description	`RPG::EventCommand` - Change Screen Color Tone
	Parameters	[2] - **0**:`RPG::Tone`, **1**:duration(frames) d `[integer]`
	Notes	Typically used in fade out (to black/white)/fade in cycles. d to be changed into ms.
225	Description	`RPG::EventCommand` - Screen Shake
	Parameters	[3] - **0**:shake power `[integer]`, **1**:shake speed `[integer]`, **2**:duration(frames) d `[integer]`
	Notes	Scarcely used in PE, {0} and {1} are not well defined so they can be deprecated. d to be changed into ms.
231	Description	`RPG::EventCommand` - Show Picture
	Parameters	See "Show Picture" section.
	Notes	
232	Description	`RPG::EventCommand` - Move Picture
	Parameters	See "Move Picture" section.
	Notes	
235	Description	`RPG::EventCommand` - Erase Picture
	Parameters	[1] - **0**:picture id `[integer]`
	Notes	
236	Description	`RPG::EventCommand` - Set Weather effect
	Parameters	[3] - **0**:weather id `[integer]`, **1**:power `[integer]`, **2**:transition duration (frames) `[integer]`
	Notes	*power* and *transition duration* to be removed. TODO:research how weather is generated. *weather id* follows "common relation 13".
241	Description	`RPG::EventCommand` - Play BGM
	Parameters	[1] - **0**:audio a `[AudioFile]`
	Notes	
242	Description	`RPG::EventCommand` - Fade Out BGM
	Parameters	[1] - **0**:duration (seconds) n `[integer]`

247	Description	`RPG::EventCommand` - Memorize BGM/BGS
	Parameters	None
	Notes	
248	Description	`RPG::EventCommand` - Restore BGM/BGS
	Parameters	None
	Notes	
249	Description	`RPG::EventCommand` - Play ME
	Parameters	[1] - **0**:audio *a* `[AudioFile]`
	Notes	
250	Description	`RPG::EventCommand` - Play SE
	Parameters	[1] - **0**:audio *a* `[AudioFile]`
	Notes	
314	Description	`RPG::EventCommand` - Restore All
	Parameters	[1] - **0**:actor id `[integer]`
	Notes	Equivalent to healing and restoring PPs. Ignore parameter.
354	Description	`RPG::EventCommand` - Return to Title Screen
	Parameters	None
	Notes	
355	Description	`RPG::EventCommand` - Script
	Parameters	[1] - **0**:script string `[String]`
	Notes	To be overhauled.
655	Description	`RPG::EventCommand` - Script (continued)
	Parameters	[1] - **0**:script string `[String]`
	Notes	To be overhauled.
402	Description	`RPG::EventCommand` - When
	Parameters	[1] - **0**:choice id `[integer]`, **1**:choice string equivalent `[integer]`
	Notes	Used with choices and conditional branches, has code block per choice.
404	Description	`RPG::EventCommand` - End of When
	Parameters	None
	Notes	
411	Description	`RPG::EventCommand` - Else
	Parameters	None
	Notes	Used with conditional branch `111`.
412	Description	`RPG::EventCommand` - Branch End
	Parameters	None
	Notes	End of a code block (as result of branching). TODO:investigate whether it is present in every code block and if it should be represented (is indentation sufficient?).
411	Description	`RPG::EventCommand` - Repeat above
	Parameters	None
	Notes	Marks end of Loop `112` code block.

[1]Movements consolidated with new *Move* command with argument.
[2]Turs consolidated with new *Turn* command with argument.
[3]Unknown algorithm to determine direction ”towards player” and ”away from player.
[4]Is part of a command sequence that should be merged in a sensible way.
[5]*step* is the horizontal offset (column), *direction* is the vertical offset.

4.3.1 Common relations

In parenthesis are the proposed representation or information :

1. 0:Top, 1:Middle, 2:Bottom
2. 0:Show, 1:Hide
3. 0:ON, 1:OFF
4. 0:Increase, 1:Decrease (`+=`,`-=`)
5. 0:Keep same, 2:Down, 4:Left, 6:Right, 8:Up (K,S,W,E,N)
6. 0:'`==`', 1:'`>=`', 2:'`<=`´', 3:'`>`', 4:'`<`', 5:'`!=`'
7. 0:constant, 1:variable
8. 0:'`>=`', 1:'`<=`'
9. 0:'`=`', 1:'`+=`', 2:'`-=`', 3:'`*=`', 4:'`/=`', 5:'`%=`' (affectation, increment, decrement, multiplication, division, modulo)
10. 0:coordinate X, 1:coordinate Y, 2:direction (3-5 unused)
11. 0:NW, 1:Centered (picture coordinate origin)
12. 0:Normal, 1:Additive, 2:Substractive (blending type)
13. 0:None, 1:Rain, 2:Storm, 3:Snow

TODO:determine if division is always rounded to an integer (and how) or not.

4.4 Complex commands

Some commands have complex behaviour that doesn't fit in the table above, therefore detailed explanation were put here instead.

4.4.1 Conditional branch - 111

This command is RMXP's equivalent of an 'if' instruction, and therefore hinges on expressing a condition. Given the expansive list of conditions that can be expressed, its syntax is quite complex.

The *first parameter* is crucial : it defines the type of condition. `integer 0-12` :

0 Check *Switch* state.

Parameters	[3] - **1**:switch id n `[integer]`, **2**:switch state d `[integer 0-1]`
Notes	d follows "common relation 3".
Representation	"If, n.toString(), d.toString()"

1 Check *Variable* value.

Parameters	[5] - **1**:variable id n `[integer]`, **2**:what it is compared to m `[integer]` **3**:constant or variable id x `[integer]`, **4**:comparator c `[integer]`
Notes	c follows "common relation 6", m follows "common relation 7".
Representation	m=='constant' : "If, n.toString(), c.toString(), x" m=='variable' : "If, n.toString(), c.toString(), x.toString()"

2 Check *Self-Switch* state.

Parameters	[3] - **1**:self switch character n `[String of size 1]`, **2**:switch state d `[integer 0-1]`
Notes	d follows "common relation 3".
Representation	"If, n, d.toString()"

6 Check *Event* direction.

Parameters	[3] - **1**:event id n `[integer]`, **2**:direction d `[integer 0-1]`
Notes	d follows "common relation 5".
Representation	"If, n.toString(), Facing, d.toString()

7 Check *Player's money.*

Parameters	[3] - **1**:amount n `[integer]`, **2**:comparator d `[integer 0-1]`
Notes	d follows "common relation 8".
Representation	"If, Money, d.toString(), n

12 Check *Script's return.*

Parameters	[2] - **1**:Script s `[String]`
Notes	Script must return a boolean (prehaps returning nothing is OK?)
Representation	"If, Script, s

Values `3,4,5,8,9,10,11` were not found in PE, therefore not researched.

4.4.2 Control variables - 122

Parameters **0** and **1** `[integer]` are indexes for the range of variables that will be affected. Variable is s

As batch control of variables is unused in PE, it is deprecated in the representation (parameter **1** is ignored).

Parameter **2** o `[integer 0-5]` sets the **operation** to be performed on the variable, and follows "common relation 9".

Parameter **3** defines the **operand type** `[integer 0-7]` :

0 - Constant.

Parameters	[5] - **4**:constant n `[integer]`
Notes	
Representation	"Control, s.toString(), o.toString(), n

2 - Random integer.

Parameters	[6] - **4**:constant a `[integer]`, **5**:constant z `[integer]`
Notes	Will choose a number $x \in [a, z]$. TODO:check if a and z are included.
Representation	"Control, s.toString(), o.toString(), [a,z]

6 - Event's attribute.

Parameters	[6] - **4**:event id n `[integer]`, **5**:attribute id d `[integer 0-2]`
Notes	d follows "common relation 10".
Representation	"Control, s.toString(), o.toString(), Event, n.toString(), d.toString()

7 - Only used once, to put the "Money"/"Gold" special variable in a temporary variable to be used in a condition, therefore isn't really needed.

Values `1,3,4,5` were not found in PE, therefore not researched.

4.4.3 Show Picture - 231

This command is only used in the intro.

Description	Display a picture.
Parameters	[10] - **0**:picture priority number p `[integer]`, **1**:picture name s `[String]`, **2**:coordinate origin c `[integer 0-1]`, **3**:unused, **4**:relative position x `[integer]`, **5**:relative position y `[integer]`, **6**:horizontal zoom zx `[integer]`, **7**:vertical zoom yx `[integer]` **8**:opacity o `[integer 0-255]`, **9**:blending type b `[integer 0-2]`
Notes	c follows "common relation 11", b follows "common relation 12".
Representation	"Show Picture, s, priority=p, coordinates=(c.toString(), x, y), zoom=(zx, zy), opacity=o, blending=b.toString()"

Picture priority number p is used when multiple pictures are on display, because overlapping textures need to have an unambiguous drawing order.

Here, let there be pictures p_1, p_2 with priorities $2, 4$ respectively. Therefore, p_1 is drawn first, then p_2. The result is that, if they are overlapping, p_2 will be drawn **over** p_1, removing parts of p_1 from being displayed.

Typically, $x = y = 0$

4.4.4 Move Picture - 232

Parameters are mostly identical to "Show Picture". This is mostly used to animate intro's pictures (movement and opacity).

Description	Move a picture.
Parameters	[10] - **0**:picture priority number p `[integer]`, **1**:duration in frames f `[integer]`, **2**:coordinate origin c `[integer 0-1]`, **3**:unused, **4**:relative position x `[integer]`, **5**:relative position y `[integer]`, **6**:horizontal zoom zx `[integer]`, **7**:vertical zoom yx `[integer]` **8**:opacity o `[integer 0-255]`, **9**:blending type b `[integer 0-2]`
Notes	c follows "common relation 11", b follows "common relation 12".
Representation	"Move Picture, priority=p, coordinates=(c.toString(), x, y), zoom=(zx, zy), opacity=o, blending=b.toString()"

5 Command Representation

The representation chosen is a result of careful consideration of its future usage requirements (including but not limited to) :

- Readability : It is destined to be read and written by humans, therefore it should be as straightforward and non-cryptic as possible.
- Brevity : In the interest of anyone (human or software) reading/writing it, the *less is more* approach is to be applied : instructions should not be longer than what is necessary.
- Unambiguity : As any formal language, its use and syntax should be unambiguous.
- Simplicity : Limiting the amount of available instructions by combining related ones is good practice.
- Expandability : There should be room left for additional behavior to be implemented.

At the time of writing these lines, representations in this document are still not final, it's a work-in-progress.

Particular decisions

- Python syntax style : Reduces explicit syntax (like semicolons and curly braces), therefore reducing syntax errors. Takes advantage of "implicit" syntax by making indentation itself meaningful.
- Case insensitive : Simplification allowing any program to simply make everything lowercase when reading an *Event*, and users to Use any casing style they prefer. This also makes it harder to have variable/switch name collisions by forcing users to explicitely name their variables.
- Switches, self-switches and variables : Should be all represented as **symbols**.

  Proposed representation : `":s" [String]` *(string beginning with colon)*

  Let `s` be the string representation (name) of the Switch/Self-switch/Variable. `s` of length 1 is to be reserved to self-switches.

  Note that merging variables and switches may allow greater flexibility for users.

Ideas

- Timers could be implemented as integers : Let `:PlayTime` be a read-olny integer variable that counts the seconds of play time (an epoch of sorts).

  Then, setting a timer for x seconds could be as simple as storing (`:PlayTime` + x) in a variable and testing it later against the current value of `:PlayTime` !
- Commands have parameters (see examples) :
  - No parameter : command line must contain the command keyword only.
  - 1 parameter : command line must contain the command keyword, plus the expected parameter `parameter_name = parameter_value` (parameter name recommended but not mandatory; parameter may be facultative)
  - n>1 parameters : command line must contain the command keyword, and the expected parameters `parameter_name = parameter_value` as a comma-separated list (no brackets; parameter name mandatory; parameter may be facultative).
  - Note on *facultative* parameters : marked with a `*`.
  - Strictly equivalent : '`:ON`'≡'`True`', '`:OFF`'≡'`False`', '`is`'≡'`==`' (when placed where a comparator would be).

5.1 Commands

Description	`Step` - Move the event (perform 1 step).
Parameters	[1] - **0**: `direction - [String]`
Notes	`direction` $\in$ {S,W,E,N,SW,NW,NE,SE,R,1F,1B,1A,1T}, see ”Directions” below.
Examples	”`Step NW`”, ”`Step 1T`”
Description	`Turn` - Turn the event (change direction).
Parameters	[1] - **0**: `direction - [String]`
Notes	`direction`, see ”Directions” below.
Examples	”`Turn N`”, ”`Turn W`”
Description	`Move Event` - Move Event to absolute/relative coordinates on the same map.
Parameters	[3] - **0**:`event* - [String/int]` (name/id of the event to move)
	1:`relative_coordinates/absolute_coordinates - [list of 2 int]`
	2:`direction* - [int]`
Notes	`event` is optional, defaults to self. `direction` is optional, defaults to ”K”.
Examples	”`Move Event relative_coordinates=[7,-5]`”,
	”`Move Event event=Jack, absolute_coordinates=[4,12]`”
Description	`Wait` - Pause event behavior execution for a given amount of time.
Parameters	[1] - **0**: `ms/s - [int]` (time in milliseconds/seconds)
Notes	If parameter name is unspecified, defaults to `s`.
Examples	”`Wait ms=3000`”, ”`Wait s=3`”
Description	`Set` - Set event properties value
Parameters	[2] - **0**: `property - [String]`, **1**: `value - [int/String/:ON/OFF]`
Notes	`property` must be a configuration variable, see ”Configuration variables” below.
	`value` must be a valid value for that property.
Examples	”`Set property=move_animation value=:ON`”
	”`Set property=Animation value=:OFF`”
	”`Set property=graphic value="trchar28,S,0"`”
Description	`Play` - Play audio.
Parameters	[3] - **0**: `SE/BGM/ME - [String]`, **1**: `volume* - [int]`, **2**: `pitch* - [int]`
Notes	`volume` and `pitch` default to 100, their values are relative to 100 (percentage).
Example	”`Play BGM="022-Field05", volume=100, pitch=100`”
Description	`Show Text`
Parameters	[1] - **0**: `text - [String]`
Example	”`Show Text "Hello, World !"`”
Description	`Choose` - Give player a list of items to choose from.
Parameters	[2] - **0**: `choices - [list of String]`, **1**: `default* - [int]` n (behavior on cancel)
Notes	If `default` not set, the player must choose (no cancel). Otherwise, select n^{th} item on the list.
Examples	”`Choose choices=["Yes","No"]`”, ”`Choose choices=["One","Two","Three"], default=1`”
Description	`Change Text Options`
Parameters	[2] - **0**: `position* - [Top/Middle/Bottom]`, **1**: `border* - [Show/Hide]` (window border))
Example	”`Change Text Options position=Middle, border=Show`”

Description	`End Execution` - Ends behavior execution.
Parameters	[0]
Example	”`End Execution`”
Description	`Label` - Marks a line as a target for a `Goto`.
Parameters	[1] - **0**: `name - [String]`
Notes	Please find a good name for the label (not like the example).
Example	”`Label "here"`”
Description	`Goto` - Change line to be executed next.
Parameters	[1] - **0**: `label - [String]`
Example	”`Goto "here"`”
Description	`Transfer Player` - Teleport player.
Parameters	[6] - **0**: `map* - [String]`, **1**: `x - [int]`, **2**: `y - [int]`
	3: `direction* - [String]`, **4**: `fading* - [:ON/:OFF]`
Notes	`map` defaults to the one the player is in. `direction` $\in$ {S,W,E,N,K}, defaults to ”K”.
	`fading` defaults to (TODO).
Example	”`Transfer Player map="Kurt's house", x=2, y=4`”
Description	`Set Move Route` - Set a sequence of commands, to be executed by a set event
Parameters	[1] - **0**: `event* - [String]`
Notes	`event` defaults to self. Must be followed by a *code block*.
	Used to move other events or to semantically indicate a ”move sequence/route”.
Example	See ”Move Route” section below.
Description	`Screen Shake`
Parameters	[1] - **0**: `duration - [int]`
Notes	`duration` is expressed in milliseconds.
Example	”`Screen Shake 600`”
Description	`Transition` - Execute transition visual effect.
Parameters	[2] - **0**: `name - [String]`, **1**: `freeze - [True/False]`
Notes	If `freeze` is enabled, stops every animation.
Example	”`Transition name="battle1", freeze=True`”
Description	`Show Picture`
Parameters	TODO
Notes	TODO.
Example	TODO
Description	`Move Picture`
Parameters	TODO
Notes	TODO.
Example	TODO
Description	`Erase Picture`
Parameters	TODO
Notes	TODO.
Example	TODO

Description	`Set weather` - Set overworld's weather.
Parameters	[2] - **0**: `name - [String]`, **1**: `duration* - [int]`
Notes	`duration` defaults to infinite duration. The effect scope of `Set weather` is to be determined (for current map, radius on the current map, across maps). Provisionally, it's limited to current map.
Example	”`Set weather name="Rainy", duration=12000`”
Description	`Fade out BGM`
Parameters	[1] - **0**: `duration - [int]`
Notes	`duration` in milliseconds.
Example	”`Fade out BGM 3000`”
Description	`Memorize BGx`
Parameters	[0]
Example	”`Memorize BGx`”
Description	`Restore BGx`
Parameters	[0]
Example	”`Restore BGx`”
Description	`Restore All`
Parameters	[0]
Notes	Restore all stats for player's party.
Example	”`Restore All`”
Description	`Return to title screen`
Parameters	[0]
Notes	Quits current game and returns to title screen (without saving).
Example	`Return to title screen`
Description	`Save`
Parameters	[1] - **0**: `allow_cancel - [True/False]`
Notes	Prompts a ”save your progress” dialog to the player.
Example	`Save allow_cancel=True`

Directions :

- S,W,E,N : South, West, East, North (vertical/horizontal movement)
- Step directions :
  - SW,NW,NE,SE : South-West, North-West, North-East, South-East (diagonal movement, not recommended)
  - R : random movement (S,W,E,N)
  - 1F,1B : one step Forwards/Backwards (according to current orientation/direction)
  - 1A,1T : one step Away from/Towards the player
- Turn directions:
  - ”90 Right”, ”90 Left” : Turn 90 degrees right/left.
  - ”random”, ”90 random” : Turn at random, turn ”90 Right” or ”90 Left” at random.
  - ”towards player”, ”away from player” : Turn based on player’s position.
- Transfer directions:
  - K : Keep the same (for teleportation)

Execution flow control :

- `if code_block [else code_block]?` : For implementing conditional execution of code blocks.
- `loop code_block` : `code_block` must contain a `break` statement for the loop to not be infinite. Infinite loop detection should be implemented.
- `choice ... [when (value) code_block]+` : For implementing behavior on player’s choice.

Total :

- 25 (+ 1*new*) commands + 3 forms of flow control !
- vs. 81 commands !
- 3 pages de doc vs. 9 pages de doc

5.2 Formal grammar

```
EVENT
    : LF* '[event]' LF+ (CONFIG LF)+ LF+ PAGE+ <EOF>

PAGE
    : '[page]' LF+ (CONFIG_OR_COND LF)* LF+ STATEMENTS '[end]' LF+

CONFIG_OR_COND
    : CONFIG_VAR '=' PARAMETER_VALUE
    | LOG_EXPR

STATEMENTS             // block of lines that define an event's behavior
    : (STATEMENT LF+)*

STATEMENT              // line that define an event's behavior
    : 'if' LOG_EXPR LF CODE_BLOCK ('else' LF CODE_BLOCK)?
    | 'loop' LF CODE_BLOCK
    | 'when' WHITESPACE VALUE LF CODE_BLOCK
    | 'break'
    | CMD
    | VAR_MANIPULATION
    | SCRIPT

CODE_BLOCK             // block of lines whose execution is subject to flow control
    : INDENT STATEMENTS DEDENT

CMD
    : CMD_ID PARAMETERS?

PARAMETERS
    : PARAMETER (',' WHITESPACE? PARAMETER)*

PARAMETER
    : (PARAMETER_NAME '=')? PARAMETER_VALUE

PARAMETER_VALUE
    : LIST
    | VALUE
    | BOOL

VAR_MANIPULATION
    : SYMBOL ASSIGN_OPERATOR EXPRESSION

EXPRESSION             // expression that returns a value
    : LOG_EXPR
    | (MATH_OP | NUMBER | SYMBOL)+ // Imperfect : allows invalid expressions
    | SCRIPT
    | PARAMETER_VALUE

LOG_EXPR               // expression that returns a logical value
    : COMPARABLE LOG_OPERATOR COMPARABLE
    | SCRIPT

NUM_EXPR               // expression that returns a numerical value
    : TERM (ADD_OP TERM)*

PARAMETER_NAME
    : WORD
```

```
LIST
    : '[' VALUE (WHITESPACE VALUE)* ']'

SCRIPT
    : s\:.*

TERM
    : FACTOR (MUL_OP FACTOR)*

FACTOR
    : NUMBER
    | '(' NUM_EXPR ')'

CMD_ID
    : WORDS

SYMBOL
    : ':' WORD

VALUE
    : NUMBER
    | STRING
    | WORD
    | TURN_VALUE

STRING
    : '"' [^"]*  '"'

NUMBER
    : -?[0-9]+('.'[0-9]+)?

LF
    : '\r\n' | '\n'

WORDS
    : WORD+

WORD
    : [a-z][a-z\_0-9]*

BOOL
    : ':ON' | ':OFF' | 'True' | 'False'

LOG_OPERATOR
    : '==' | '>=' | '<=' | '>' | '<' | '!='

ASSIGN_OPERATOR
    : '=' | '+=' | '-=' | '*=' | '/='

MATH_OP
    : '+' | '-' | '*' | '/'

COMMENT                // Rejected by the lexer
    : #.*

SPACE                  // Rejected by the lexer
    : [ \t]+
```

- `CMD_ID` is expected to be one of the defined operation. An error should be thrown otherwise.
- Comments must be stripped before lexing. Multi-line comments aren't supported.

- Tokens (terminal values) `INDENT` and `DEDENT` should be generated when reading the event file in order to represent indentation, thus allowing for block of statements to be syntactically represented.

5.2.1 Configuration variables

Mostly contained in the event, but can be overridden by the pages.

CONFIG_VAR	**type**	**Default**	**Description**.
`name`	`String`	N/A	Identifies the event.
`xy`	`[int, int]`	N/A*	Position of the event.
`graphic`	`String/int`	None	Texture of the event.
`pattern`	`int`	0	Column index for the sub-texture from `graphic` to use.
`opacity`	`int`	255	`0-255` Opacity for event's texture.
`transparent`	`bool`	False	Transparency flag. When enabled, `graphic` isn't displayed.
`direction`	`String`	S	[N,E,S,W] Initial facing direction (if has `graphic`).
`trigger`	`String`	"onPlayerAction"	Trigger for the behavior of the event.
`move_animation`	`bool`	True	Whether the graphic should be animated when moving/walking.
`stop_animation`	`bool`	False	Whether the graphic should be animated when not moving/walking.
`direction_fix`	`bool`	False	The direction (of the texture) of the event cannot be changed when True.
`through`	`bool`	False	"Walk through walls" switch: when True, collision is ignored and the event can go anywhere (walk on water, walls, holes, etc).
`always_on_top`	`bool`	False	Event's graphic should be drawn last, as to always be "on top" of everything else. Scarcely used.
`movement`	`String`	"Fixed"	"Fixed", "Random" or "Approach".
`movement_speed`	`String`	"Slow"	"Slow" or "Fast". Vaguely defined. Player's movement is "Fast".
`preset`	`String`	None	Proposed "preset" for simple, common events (boulder, door, etc).

* : Mandatory configuration, therefore no default.

Notes :

- `graphic` can be either a string (name of a character file) or a int (tile id from the current tileset). Defaults to None : the event has no texture.
- `move_animation:False, stop_animation:True` is mostly used for berry trees.
- As anything in an event file, it should be read in a case-insensitive way.
- `trigger` can have values :
  - *onPlayerAction* : The event is triggered by the player interacting (using action button) with it.
  - *onPlayerTouch* : The event is triggered by the player touching (walking into) it.
  - *onTouch* : The event is triggered by the player touching (walking into) it OR the event touching the player.
  - *onAutorun* : The event is triggered when the map is loaded.
  - *ready* : The event is always triggered, its execution is controlled through its behavior conditions.
  - *onSeen n* : The event is triggered when the player is on the event's line of sight, within n tiles (n is optional, defaults to no limit)

5.3 Notes

Unfortunately, it is not possible to cover every command used in PE, just as it is not possible to extract the underlying semantic behind every event, for the simple reason that PE doesn't always implement things in a straightforward way.

Reading some events, it appears obvious that the authors of PE had to work around limitations of event commands, relying on scripts to expand capabilities. These result in artifacts.

These include, but are not limited to :

- Recurring events : Some events, like *doors*, are common and have straightforward behavior, so authors just copy-pasted them everywhere they were needed, only applying modifications when necessary (eg: appearance and transfer destination on doors).

  These were the motivation behind the creation of the `preset` configuration variable on events. It would allow for all recurring commands to be abstracted away, allowing for shorter and cleaner events.

- Text hack : According to PE's wiki, there are plenty of modifiers that can be integrated to text in order to modify its behavior : changing text font, size, setting it bold, italic, changing its position or alignment, displaying a selection menu, etc..

  This would need to be re-implemented entirely to replicate behavior.

- Arbitrary code : The ability to execute scripts in events, and the global nature of most elements in the game, allows scripts to perform basically any action.

  Replicating this much flexibility without a Ruby interpreter and PE's original scripts would be completely impractical. The only sensible way forward would be to implement the basic function calls and elevate the abstraction level for complex behavior, or fixing it by hand. Decision are to be made on a case-by-case basis.

- Arbitrary variable use : This is not exactly an artifact or RMXP's limitations, but one of PE's authors. They sometimes use variables, whose name imply a certain usage scope, for unrelated purposes .

  This could have been simply avoided by creating new variables. It is not technically an issue : the game already runs with these artifacts, therefore it doesn't need fixing.

  There is no other solution than fixing it by hand (by creating new variables and changing usage).

6 Maps

Here we will focus on `RPG::Map`. Here are its components :

`tileset_id`	int	Value of a `RPG::Tileset` unique identifier component `id`. The `RPG::Tileset` object can be retrieved through the global hash `$data_tilesets` using the id as the key.
`width,height`	int,int	Attribute equivalent to `data.xsize()` and `data.ysize()`.
`autoplay_bgX`	bool	Indicated whether an audio is to be played as soon as the map is loaded.
`bgm/bgs`	AudioFile	The audio that is to be played when loading the map. *bgs unused by PE*
`encounter_list`	Array	*Unused by PE.*
`encounter_step`	int	*Unused by PE.*
`data`	Table of int	Contain the *map* representation of the 3 tile layers.
`events`	Hash	Contain the *Event* representation (`RPG::Event`) for this map.

6.1 Associated classes

- The role of the associated `Game_Map` instance is to be studied further, but current understanding indicated that it is an alias derived from its `RPG::Map` instance that is tailored for PE's needs.
- About the associated `RPG::MapInfo` instance : It contains a few useful informations :

`name`	String	The name of the map.
`parent_id`	int	In the map tree, the id of the parent map.

  This information can retrieved directly from the compiled *MapInfos* file :

  ```
  mapinfos = pbLoadRxData("Data/MapInfos")
  map_name = mapinfos[id].name
  parent_map_id    = mapinfos[id].parent_id
  parent_map_name = mapinfos[parent_map_id].name rescue nil
  ```

  RMXP allows maps to be structured in a hierarchy, where a map can have a "parent map", but this is only used in the UI to emulate a file system-like tree. This is purely cosmetic. Only the `name` value will be used.

- `RPG::Tileset` : Represents a normal tileset :

`id`	int	The id of the tileset.
`name`	String	Its name (no extension).
`tileset_name`	String	Name of tileset. *Moved to Map.*
`autotile_names`	Array of String	Names of associated autotiles (up to 7). *Moved to Map.*
`panorama_*`		*Unused by PE.*
`fog_*`		*Unused by PE.*
`battleback_name`	String	Name of the texture that appears during combat. *Moved to Map.*
`passages`	2D Table of int	Properties of individual textures.
`priorities`	2D Table of int	Properties of individual textures.
`terrain_tags`	2D Table of int	Properties of individual textures.

- `RPG::AudioFile` : Basic data container :

`name`	String	The name of the audio file (no extension).
`volume`	int	Acts like a volume slider, normalized at 100.
`pitch`	int	Allows to adjust sound pitch, normalized at 100.

  A global variable (`$data_tilesets, Array`) stores this information.

- `Table` : Used for 2D/3D arrays, with 3 class mathods to retrieve dimensions. x and y correspond to their GUI map representation and z the map layers (background, intermediate, foreground).

6.1.1 Values for tileset tables

Each table contains `int` values, one for each texture. This value is to be interpreted .

`passages`: let's consider the 6 least significant bits

- bit 0 : Cannot move S
- bit 1 : Cannot move W
- bit 2 : Cannot move E
- bit 3 : Cannot move N
- bit 4 : Is a bush
- bit 5 : Is a counter (tile through which interaction is possible)

`terrain_tags`: see `PBTerrain` module for values.

`priorities`: default value is 0. Any higher value means that the texture has priority. In practice, it means that the texture is "above" its own layer (drawn last). Combined with passability, it's possible for it to be on the same layer as NPCs/the player and give the illusion that they can pass behind it.

Proposition : integrate `priorities` to `passages` as a 7th bit (*bit 6 : Can be passed behind*).

6.2 About graphical assets

When dealing with (most) graphical assets in RPG Maker XP, including tilesets, autotiles and maps, a few constraints apply.

- The base unit is the **tile**, which is a 32 by 32 square.
- Tilesets must have a horizontal dimension of exactly 8 tiles (256 pixels), but can be arbitrarily tall (n tiles tall).
- Tilesets can have up to 7 associated autotiles. This has proven to be a limiting factor in PE.
- Autotiles are special assets. They can be put on a map like any texture from a tileset, but have the properties of being context-aware and animation-capable :

  They form coherent surfaces by manipulating components of their texture in order to give the impression of continuity when multiple instances of the same autotile are neighbors. They can be used to create basically any surface that needs to deal with how its border with an other surface looks.

  I identified two formats (*frames are situated side-by-side horizontally*) :

  - $3N \times 4$: a 3 tile horizontal, 4 tile vertical, N frame image. This is the official autotile format for RMXP.
  - $N \times 1$: a 1 tile horizontal, 1 tile vertical, N frame image. This is used for animated tiles.

- Every tile has properties (see section "values for tileset tables"). This includes autotiles, which notably have a single `passages`, `terrain_tag` and `priorities` value.
- During my map reconstruction attempts, I found out that most maps only use a fraction of tiles available to them and programmed a way of converting maps and their tilesets to a "compact" format (creating an alternate tileset with only used tiles, and adapting map data accordingly).

  Although it is functional and may be advantageous for running on low memory systems, the scattering of graphical assets and the loss of tile adjacency render this approach pointless or impractical.

I believe the decision of tying tiles and autotiles together in their object representation, and then using the original tileset file name to refer to said object in maps, was a poor design choice. In consequence, the extraction script decouples maps, autotiles and tilesets, allowing for more flexibility (for example, it raises the possibility of removing the 7 autotile per tileset limit).

6.3 Autotile format

Researching how autotiles are adaptively generated proved to be a tedious manual process of reverse-engineering.

I used the "test map" that was created as a starting point for studying Pokémon Essentials. By placing autotiles in various shapes and extracting map data, I was able to manually correlate tile content to their index (and understand both the absolute and relative indexing systems).

It turns out that autotiles tiles are divided into four separate "sub-tiles" of 16 by 16 pixels, and each index correspond to a combination of sub-tiles into a unique tile.

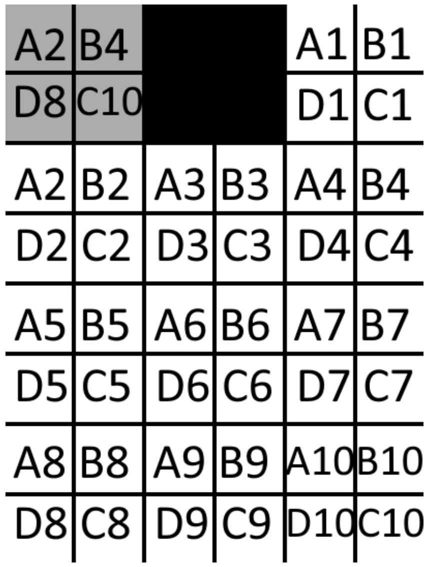


Figure 2: 3 by 4, single frame autotile format

As you can see, only 10 tiles are actually used out of 12. Some autotile assets contained texture for the redundant/unused tiles for some unidentified reason, which make me suspect there might be something I'm missing about autotiles.

The result of my research can be found in the `AutotilesSubtileMap.ods` spreadsheet file. It lists indexes and their corresponding subtile components. I also implemented a Python program (`LoadImage.py`) that reconstructs maps from map data, tileset and autotiles, including GIF output (see `Map032_out.gif` for example), demonstrating the feasability of lossless map extraction and reconstruction.

Note : I found this article helpful for understanding how autotiles work.

6.4 Map representation

At its core, a RPG Make XP map is a *tiled map* : it is a 2-dimensional grid of textures (tiles) of fixed size.

The `data` component is a 3-dimensional table of integer values with the following properties :

- The 3rd dimension is used to represent **layers** : exactly 3 tiled maps are used for any RMXP map :
  - Background : Contains mainly the textures that make the ground and other elements that are always "below player's level". Any event or texture of higher layer will be displayed *above* it.
  - Intermediate : Contains mainly the textures that should be "at player's level", which includes most elements the player can interact with (including bumping into).
  - Foreground : Contains mainly the textures that should be "above player's level", typically used for elements below which the player can stand.
- Each layer obeys the same indexing convention :

Value(s)	**Description**
`0`	Reserved value for "No texture"
`1-47`	Reserved, unused.
`48-95`	Range used for autotile 1.
`96-143`	Range used for autotile 2.
⋮	⋮
`336-383`	Range used for autotile 7.
`384-`	Range used for tileset.

  This way of reserving 48 indexes per autotile results from autotile's mechanism for generating context-aware textures.

  Note : each range describes the *absolute positions* between which a *relative indexing system* takes place. For example, index 52 is interpreted as index 4 for autotile 1 and index 485 is index 100 on the tileset (remember that indexes begin at zero, not one).

6.5 Map and Tileset files

There should be a well-defined way of representing extracted map and tileset information.

Map

- Located in the "`Maps`" directory.
- Naming convention : `<id>_<name>.json` . The *name* is only here as a quality-of-life addition, for developers to easily know what map they're dealing with. It must be present, though.

  Extension isn't really important and can always be changed in the future.
- Location agnostic : A map file can be at the root of the "Maps" directory, or in any subdirectory, allowing for the same flexibility as RMXP's UI.
- Content : utf-8 encoded JSON with the following entries

`_class`	String	Must be `"Map"`.
`name`	String	Map's name. Used for displaying current location.
`width`	int	Map's width. Should be checked against the content of `table`.
`height`	int	Map's height. Should be checked against the content of `table`.
`battleback`	String	Picture to be displayed behind battles.
`tileset`	String	Map's tileset (file name without extension).
`autotiles`	Array of String	Map's autotiles (file name without extension).
`autoplay_bgm`	bool	Sets whether the bmg should be played when entering the map.
`bgm`	String	Map's background music.
`table`	3D array of int	Describes map's texture placement (3 layers).

  Note : `bgm` formats : `"<name>"` or `"<name>,<volume>,<pitch>"`

  Note : `table` must have dimensions `width x height x 3`

Tileset and Autotiles

- Located in the "`Tileset_data\Tilesets`" and "`Tileset_data\Autotiles`" directories respectively.
- Naming convention : `<name>.json` . The *name* is only here as a quality-of-life addition, for developers to easily know what map they're dealing with. It must be present, though.
- Content : JSON with the following entries

`_class`	String	Must be `"Tileset"`.
`name`	String	Tileset's file name (no extension). Referenced by map's property `tileset`
`passages`	(1D array of) int	Tileset's passage table.
`terrain_tags`	(1D array of) int	Tileset's terrain tag table.

  Note : for autotiles, all values in `passages` and `terrain_tags`, therefore these fields were simplified to a *single integer value.*

  Note : RMXP seem to fail to load tilesets/autotiles after an extraction with destination "`Graphics\Tilesets`" and "`Graphics\Autotiles`" directories, probably because there are foreign files in the graphic folder. For that reason, other directories were used.
- Advantages : Decoupling a `Tileset` from the autotilesets used for a particular map allows added flexibility.

6.5.1 On naming decisions

I was asked about the choice of using a numerical identifier in the file names, and why I didn't choose to use name identifiers instead. This is a decision that was taken after careful consideration :

- First of all, numerical identification was originally used for maps, tilesets, etc

  Therefore, transitioning to another identification system would be complex and an exercise in reinventing the wheel, all that for questionable gain.

- Using a file name identifier means that information needs to reside inside the file itself.

  Without it, some other strategy of file identification would be needed :

  - Reading each file, looking for the one containing the right id
  - A database associating each file with its id

  Both of these aren't particularly attractive.

- The idea of using names for identification is attractive at first glance : user-friendly and intuitive, it's basically the greatest thing since sliced bread !

  Unfortunately, there are some issues with this solution, including but not limited to :

  - As stated before, it would be complex to transition to this new identification system.
  - Not all characters are usable : every file system imposes limitations, which would impose unwanted restrictions for developers.
  - Dealing with names/strings means that ids are typically longer and less formally defined (can contain more caracters, including casing, accents, etc), therefore amplifying the risk of any id containing errors.
  - Developers involved in this type of project are typically capable of dealing with numerical ids without issue already.
  - For large projects with hundreds/thousands of maps, name collisions may force developers to use convoluted or cumbersome naming schemes.

  Note that some of the issues identified may be circumvented by re-introducing the "name" field in the files themselves, but at this point the percieved value of the change would become nil.

- While it is true that numerical id collisions is possible and using name ids may help preventing them, there are other strategies available.

  Planning, for example : reserving ranges of values for specific uses ahead of time.

In conclusion, it is my estimation that using numerical ids is a reasonable choice, as it is a tried-and-true that doesn't compromise on usability (at least not too much).

On the other hand, the suggestion of abandoning the 3 digit format for numerical ids was considered and adopted, as it would allow larger projects to exist and didn't pose any technical problem.

7 Remarks

7.1 Contact

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7.2 Privacy Policy