

University  
of GlasgowSchool of  
Computing Science

# CSC1104 – Computer Organisation & Architecture

## Laboratory/Tutorial 1: Components and Performance of Computers

Associate Professor Cao Qi  
[Qi.Cao@Glasgow.ac.uk](mailto:Qi.Cao@Glasgow.ac.uk)

### Objectives

- Evaluate the program and CPU performance.
- Identify the major components and ports of Raspberry Pi 4 and their function.

### Questions:

1. A program written in Java runs 15 seconds on a processor. A new Java compiler is released that requires only 0.6 as many instructions as the old compiler. Unfortunately, it increases the CPI by 1.1. How fast can this program run with the new compiler?

### Solution:

❑ Execution time for old compiler =  $\text{Instruction count}_{\text{old}} \times \text{CPI}_{\text{old}} \times \text{Clock cycle time}$ .

Hence, 15 seconds =  $\text{Instruction count}_{\text{old}} \times \text{CPI}_{\text{old}} \times \text{Clock cycle time}$ .

❑ Execution time for new compiler =  $\text{Instruction count}_{\text{new}} \times \text{CPI}_{\text{new}} \times \text{Clock cycle time}$ .

❑  $\text{Instruction count}_{\text{new}} = 0.6 * \text{Instruction count}_{\text{old}}$

❑  $\text{CPI}_{\text{new}} = 1.1 * \text{CPI}_{\text{old}}$

$$\frac{\text{Execution time for new compiler}}{\text{Execution time for old compiler}} = \frac{\text{Instruction Count}_{\text{new}} \times \text{CPI}_{\text{new}} \times \text{Clock cycle time}}{\text{Instruction Count}_{\text{old}} \times \text{CPI}_{\text{old}} \times \text{Clock cycle time}}$$

CPU execution time for new compiler =  $15 \times 0.6 \times 1.1 = 9.9$  seconds.

2. Please derive the detailed size of these terms one by one.

$$8 \text{ GHz} = \underline{8,000 (8 \times 10^3)} \text{ MHz} = \underline{8,000,000 (8 \times 10^6)} \text{ KHz} = \underline{8,000,000,000 (8 \times 10^9)} \text{ Hz}$$

$$16 \text{ GHz} = \underline{16 \times 10^3} \text{ MHz} = \underline{16 \times 10^6} \text{ KHz} = \underline{16 \times 10^9} \text{ Hz}$$

$$40 \text{ MHz} = \underline{0.04} \text{ GHz} = \underline{40 \times 10^3} \text{ KHz} = \underline{40 \times 10^6} \text{ Hz}$$

$$600 \text{ MHz} = \underline{0.6} \text{ GHz} = \underline{600 \times 10^3} \text{ KHz} = \underline{600 \times 10^6} \text{ Hz}$$

$$300 \text{ KHz} = \underline{0.0003} \text{ GHz} = \underline{0.3} \text{ MHz} = \underline{300 \times 10^3} \text{ Hz}$$

$$5000 \text{ KHz} = \underline{0.005} \text{ GHz} = \underline{5} \text{ MHz} = \underline{5 \times 10^6} \text{ Hz}$$

$$4 \text{ GiByte} = \underline{4 \times 1024} \text{ MiByte} = \underline{4 \times 1024^2} \text{ KiByte} = \underline{4 \times 1024 \times 1024 \times 1024 (4 \times 1024^3)} \text{ Bytes}$$

$$20 \text{ GiByte} = \underline{20 \times 1024 (20 \times 2^{10})} \text{ MiByte} = \underline{20 \times 1024^2 (20 \times 2^{20})} \text{ KiByte} = \underline{20 \times 1024^3 (20 \times 2^{30})} \text{ Bytes}$$

$$100 \text{ MiByte} = \frac{100}{1024} \underline{(100 \times 2^{-10})} \text{ GiByte} = \underline{100 \times 1024 (100 \times 2^{10})} \text{ KiByte} = \underline{100 \times 1024^2 (100 \times 2^{20})} \text{ Bytes}$$

$$90 \text{ KiByte} = \frac{90}{1024 \times 1024} \underline{(90 \times 2^{-20})} \text{ GiByte} = \frac{90}{1024} \underline{(90 \times 2^{-10})} \text{ MiByte} = \underline{90 \times 1024 (90 \times 2^{10})} \text{ Bytes}$$

$$1 \text{ second} = \underline{1000} \text{ ms} = \underline{1 \times 10^6} \text{ } \mu\text{s} = \underline{1 \times 10^9} \text{ ns} = \underline{1 \times 10^{12}} \text{ ps}$$

$$200 \text{ ms} = \underline{0.2} \text{ s} = \underline{200 \times 10^3} \text{ } \mu\text{s} = \underline{200 \times 10^6} \text{ ns} = \underline{200 \times 10^9} \text{ ps}$$

$$150 \text{ } \mu\text{s} = \underline{150 \times 10^{-6}} \text{ s} = \underline{150 \times 10^{-3}} \text{ ms} = \underline{150 \times 10^3} \text{ ns} = \underline{150 \times 10^6} \text{ ps}$$

$$600 \text{ ns} = \underline{600 \times 10^{-9}} \text{ s} = \underline{600 \times 10^{-6}} \text{ ms} = \underline{600 \times 10^{-3}} \text{ } \mu\text{s} = \underline{600 \times 10^3} \text{ ps}$$

$$800 \text{ ps} = \underline{800 \times 10^{-12}} \text{ s} = \underline{800 \times 10^{-9}} \text{ ms} = \underline{800 \times 10^{-6}} \text{ } \mu\text{s} = \underline{800 \times 10^{-3}} \text{ ns}$$

3. Using a typical benchmark program running on 2 computers, the following machine characteristics result:

| Computer | Clock Rate (MHz) | Performance (MIPS) | CPU Execution Time (secs) |
|----------|------------------|--------------------|---------------------------|
| A        | 5                | 1                  | 12x                       |
| B        | 25               | 18                 | x                         |

The final column shows that the Computer A required 12 times longer than the Computer B measured in CPU execution time.

- What is the **relative size of the instruction count** of the machine code for this benchmark program running on the two machines?
- What are the CPI values for the two machines?

**Solution:**

According to the MIPS rate equation as follows:

$$\text{MIPS rate} = \frac{\text{Instruction count}}{\text{Execution time} \times 10^6} = \frac{1}{\text{CPI} \times \text{Clock Cycle time} \times 10^6} = \frac{\text{Clock Rate}}{\text{CPI} \times 10^6}$$

So, we can calculate instruction count and CPI on these 2 computers.

$$\text{Instruction count}_A = \text{MIPS rate}_A \times \text{Execution time}_A \times 10^6 = 1 \times 12x \times 10^6 = 12x \times 10^6.$$

$$\text{Instruction count}_B = \text{MIPS rate}_B \times \text{Execution time}_B \times 10^6 = 18 \times x \times 10^6 = 18x \times 10^6.$$

$$\text{Instruction count}_B / \text{Instruction count}_A = 18x \times 10^6 / 12x \times 10^6 = 1.5.$$

$$\text{CPI}_A = \text{Clock Rate}_A / (\text{MIPS rate}_A \times 10^6) = 5 \times 10^6 / (1 \times 10^6) = 5.$$

$$\text{CPI}_B = \text{Clock Rate}_B / (\text{MIPS rate}_B \times 10^6) = 25 \times 10^6 / (18 \times 10^6) = 1.389.$$

4. Consider two different computers, with two different instruction sets, both of which have a clock rate of 200 MHz. The following measurements are recorded on the two machines running a given set of benchmark programs:

| Instruction Type     | Instruction Count (millions) | Cycles per Instruction |
|----------------------|------------------------------|------------------------|
| <b>Computer A</b>    |                              |                        |
| Arithmetic and logic | 8                            | 1                      |
| Load and store       | 4                            | 3                      |
| Branch               | 2                            | 4                      |
| Others               | 4                            | 3                      |
| <b>Computer B</b>    |                              |                        |
| Arithmetic and logic | 10                           | 1                      |
| Load and store       | 8                            | 2                      |
| Branch               | 2                            | 4                      |
| Others               | 4                            | 3                      |

Determine and compare the average CPI, MIPS rate, and execution time for each computer.

### Solution:

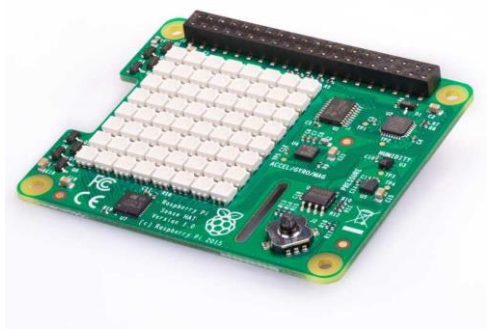
#### For computer A:

- Total No. of instructions executed by Computer A are:  $8+4+2+4=18$  (million).
- Total number of CPU clock cycles needed by Computer A are:  
 $\sum(\text{instruction count}_i * \text{CPI}_i \text{ of each instruction}) = 8*1+4*3+2*4+4*3 = 40$  (million-cycles).
- Average CPI of Computer A is:  $40 / 18 = 2.22$  (Cycles/instruction).
- MIPS rate of Computer A is  $\frac{\text{Clock Rate}}{\text{CPI} \times 10^6}$ :  $200 * 10^6 / (2.22 * 10^6) = 90$ .
- CPU execution time of Computer A is:  $\text{instruction count} * \text{CPI} / \text{Clock Rate} = 40 \text{ million} / (200 * 10^6) = 0.2$  seconds.

#### For computer B:

- Total No. of instructions executed by Computer B are:  $10+8+2+4=24$  (million).
- Total number of CPU clock cycles needed by Computer B are:  
 $\text{sum}(\text{instruction count}_i * \text{CPI}_i \text{ of each instruction}) = 10*1+8*2+2*4+4*3 = 46$  (million-cycles).
- Average CPI of Computer B is:  $46 / 24 = 1.92$  (Cycles/instruction).
- MIPS rate of Computer B is  $\frac{\text{Clock Rate}}{\text{CPI} \times 10^6}$ :  $200 * 10^6 / (1.92 * 10^6) = 104$ .
- CPU execution time of Computer B is:  $\text{instruction count} * \text{CPI} / \text{Clock Rate} = 46 \text{ million} / (200 * 10^6) = 0.23$  seconds.

5. Please perform a literature study on the hardware structure of a Raspberry Pi 4 Model B+ platform and the sensor HAT board. Please identify its major components, ports, types of sensors and their functions.



### Solution:

- The major components on Raspberry Pi 4 Model B+ are shown below.
- The major components of Raspberry Pi Sense HAT are shown next.

|           |   |              |          |     |     |
|-----------|---|--------------|----------|-----|-----|
| 3V3 Power | 1 | 2            | 5V Power | 17  | 18  |
| GPIO 1    | 4 | SPD1 MOSI    | 3        | 19  | 20  |
| GPIO 2    | 4 | SPD1 MISO    | 3        | 21  | 22  |
| GPIO 3    | 4 | SPD1 SCL     | 3        | 23  | 24  |
| GPIO 4    | 4 | SPD1 CE1 N   | 3        | 25  | 26  |
| GPIO 5    | 4 | SPD1 CE1 P   | 3        | 27  | 28  |
| GPIO 6    | 4 | SPD1 CE2 N   | 3        | 29  | 30  |
| GPIO 7    | 4 | SPD1 CE2 P   | 3        | 31  | 32  |
| GPIO 8    | 4 | SPD1 CE3 N   | 3        | 33  | 34  |
| GPIO 9    | 4 | SPD1 CE3 P   | 3        | 35  | 36  |
| GPIO 10   | 4 | SPD1 CE4 N   | 3        | 37  | 38  |
| GPIO 11   | 4 | SPD1 CE4 P   | 3        | 39  | 40  |
| GPIO 12   | 4 | SPD1 CE5 N   | 3        | 41  | 42  |
| GPIO 13   | 4 | SPD1 CE5 P   | 3        | 43  | 44  |
| GPIO 14   | 4 | SPD1 CE6 N   | 3        | 45  | 46  |
| GPIO 15   | 4 | SPD1 CE6 P   | 3        | 47  | 48  |
| GPIO 16   | 4 | SPD1 CE7 N   | 3        | 49  | 50  |
| GPIO 17   | 4 | SPD1 CE7 P   | 3        | 51  | 52  |
| GPIO 18   | 4 | SPD1 CE8 N   | 3        | 53  | 54  |
| GPIO 19   | 4 | SPD1 CE8 P   | 3        | 55  | 56  |
| GPIO 20   | 4 | SPD1 CE9 N   | 3        | 57  | 58  |
| GPIO 21   | 4 | SPD1 CE9 P   | 3        | 59  | 60  |
| GPIO 22   | 4 | SPD1 CE10 N  | 3        | 61  | 62  |
| GPIO 23   | 4 | SPD1 CE10 P  | 3        | 63  | 64  |
| GPIO 24   | 4 | SPD1 CE11 N  | 3        | 65  | 66  |
| GPIO 25   | 4 | SPD1 CE11 P  | 3        | 67  | 68  |
| GPIO 26   | 4 | SPD1 CE12 N  | 3        | 69  | 70  |
| GPIO 27   | 4 | SPD1 CE12 P  | 3        | 71  | 72  |
| GPIO 28   | 4 | SPD1 CE13 N  | 3        | 73  | 74  |
| GPIO 29   | 4 | SPD1 CE13 P  | 3        | 75  | 76  |
| GPIO 30   | 4 | SPD1 CE14 N  | 3        | 77  | 78  |
| GPIO 31   | 4 | SPD1 CE14 P  | 3        | 79  | 80  |
| GPIO 32   | 4 | SPD1 CE15 N  | 3        | 81  | 82  |
| GPIO 33   | 4 | SPD1 CE15 P  | 3        | 83  | 84  |
| GPIO 34   | 4 | SPD1 CE16 N  | 3        | 85  | 86  |
| GPIO 35   | 4 | SPD1 CE16 P  | 3        | 87  | 88  |
| GPIO 36   | 4 | SPD1 CE17 N  | 3        | 89  | 90  |
| GPIO 37   | 4 | SPD1 CE17 P  | 3        | 91  | 92  |
| GPIO 38   | 4 | SPD1 CE18 N  | 3        | 93  | 94  |
| GPIO 39   | 4 | SPD1 CE18 P  | 3        | 95  | 96  |
| GPIO 40   | 4 | SPD1 CE19 N  | 3        | 97  | 98  |
| GPIO 41   | 4 | SPD1 CE19 P  | 3        | 99  | 100 |
| GPIO 42   | 4 | SPD1 CE20 N  | 3        | 101 | 102 |
| GPIO 43   | 4 | SPD1 CE20 P  | 3        | 103 | 104 |
| GPIO 44   | 4 | SPD1 CE21 N  | 3        | 105 | 106 |
| GPIO 45   | 4 | SPD1 CE21 P  | 3        | 107 | 108 |
| GPIO 46   | 4 | SPD1 CE22 N  | 3        | 109 | 110 |
| GPIO 47   | 4 | SPD1 CE22 P  | 3        | 111 | 112 |
| GPIO 48   | 4 | SPD1 CE23 N  | 3        | 113 | 114 |
| GPIO 49   | 4 | SPD1 CE23 P  | 3        | 115 | 116 |
| GPIO 50   | 4 | SPD1 CE24 N  | 3        | 117 | 118 |
| GPIO 51   | 4 | SPD1 CE24 P  | 3        | 119 | 120 |
| GPIO 52   | 4 | SPD1 CE25 N  | 3        | 121 | 122 |
| GPIO 53   | 4 | SPD1 CE25 P  | 3        | 123 | 124 |
| GPIO 54   | 4 | SPD1 CE26 N  | 3        | 125 | 126 |
| GPIO 55   | 4 | SPD1 CE26 P  | 3        | 127 | 128 |
| GPIO 56   | 4 | SPD1 CE27 N  | 3        | 129 | 130 |
| GPIO 57   | 4 | SPD1 CE27 P  | 3        | 131 | 132 |
| GPIO 58   | 4 | SPD1 CE28 N  | 3        | 133 | 134 |
| GPIO 59   | 4 | SPD1 CE28 P  | 3        | 135 | 136 |
| GPIO 60   | 4 | SPD1 CE29 N  | 3        | 137 | 138 |
| GPIO 61   | 4 | SPD1 CE29 P  | 3        | 139 | 140 |
| GPIO 62   | 4 | SPD1 CE30 N  | 3        | 141 | 142 |
| GPIO 63   | 4 | SPD1 CE30 P  | 3        | 143 | 144 |
| GPIO 64   | 4 | SPD1 CE31 N  | 3        | 145 | 146 |
| GPIO 65   | 4 | SPD1 CE31 P  | 3        | 147 | 148 |
| GPIO 66   | 4 | SPD1 CE32 N  | 3        | 149 | 150 |
| GPIO 67   | 4 | SPD1 CE32 P  | 3        | 151 | 152 |
| GPIO 68   | 4 | SPD1 CE33 N  | 3        | 153 | 154 |
| GPIO 69   | 4 | SPD1 CE33 P  | 3        | 155 | 156 |
| GPIO 70   | 4 | SPD1 CE34 N  | 3        | 157 | 158 |
| GPIO 71   | 4 | SPD1 CE34 P  | 3        | 159 | 160 |
| GPIO 72   | 4 | SPD1 CE35 N  | 3        | 161 | 162 |
| GPIO 73   | 4 | SPD1 CE35 P  | 3        | 163 | 164 |
| GPIO 74   | 4 | SPD1 CE36 N  | 3        | 165 | 166 |
| GPIO 75   | 4 | SPD1 CE36 P  | 3        | 167 | 168 |
| GPIO 76   | 4 | SPD1 CE37 N  | 3        | 169 | 170 |
| GPIO 77   | 4 | SPD1 CE37 P  | 3        | 171 | 172 |
| GPIO 78   | 4 | SPD1 CE38 N  | 3        | 173 | 174 |
| GPIO 79   | 4 | SPD1 CE38 P  | 3        | 175 | 176 |
| GPIO 80   | 4 | SPD1 CE39 N  | 3        | 177 | 178 |
| GPIO 81   | 4 | SPD1 CE39 P  | 3        | 179 | 180 |
| GPIO 82   | 4 | SPD1 CE40 N  | 3        | 181 | 182 |
| GPIO 83   | 4 | SPD1 CE40 P  | 3        | 183 | 184 |
| GPIO 84   | 4 | SPD1 CE41 N  | 3        | 185 | 186 |
| GPIO 85   | 4 | SPD1 CE41 P  | 3        | 187 | 188 |
| GPIO 86   | 4 | SPD1 CE42 N  | 3        | 189 | 190 |
| GPIO 87   | 4 | SPD1 CE42 P  | 3        | 191 | 192 |
| GPIO 88   | 4 | SPD1 CE43 N  | 3        | 193 | 194 |
| GPIO 89   | 4 | SPD1 CE43 P  | 3        | 195 | 196 |
| GPIO 90   | 4 | SPD1 CE44 N  | 3        | 197 | 198 |
| GPIO 91   | 4 | SPD1 CE44 P  | 3        | 199 | 200 |
| GPIO 92   | 4 | SPD1 CE45 N  | 3        | 201 | 202 |
| GPIO 93   | 4 | SPD1 CE45 P  | 3        | 203 | 204 |
| GPIO 94   | 4 | SPD1 CE46 N  | 3        | 205 | 206 |
| GPIO 95   | 4 | SPD1 CE46 P  | 3        | 207 | 208 |
| GPIO 96   | 4 | SPD1 CE47 N  | 3        | 209 | 210 |
| GPIO 97   | 4 | SPD1 CE47 P  | 3        | 211 | 212 |
| GPIO 98   | 4 | SPD1 CE48 N  | 3        | 213 | 214 |
| GPIO 99   | 4 | SPD1 CE48 P  | 3        | 215 | 216 |
| GPIO 100  | 4 | SPD1 CE49 N  | 3        | 217 | 218 |
| GPIO 101  | 4 | SPD1 CE49 P  | 3        | 219 | 220 |
| GPIO 102  | 4 | SPD1 CE50 N  | 3        | 221 | 222 |
| GPIO 103  | 4 | SPD1 CE50 P  | 3        | 223 | 224 |
| GPIO 104  | 4 | SPD1 CE51 N  | 3        | 225 | 226 |
| GPIO 105  | 4 | SPD1 CE51 P  | 3        | 227 | 228 |
| GPIO 106  | 4 | SPD1 CE52 N  | 3        | 229 | 230 |
| GPIO 107  | 4 | SPD1 CE52 P  | 3        | 231 | 232 |
| GPIO 108  | 4 | SPD1 CE53 N  | 3        | 233 | 234 |
| GPIO 109  | 4 | SPD1 CE53 P  | 3        | 235 | 236 |
| GPIO 110  | 4 | SPD1 CE54 N  | 3        | 237 | 238 |
| GPIO 111  | 4 | SPD1 CE54 P  | 3        | 239 | 240 |
| GPIO 112  | 4 | SPD1 CE55 N  | 3        | 241 | 242 |
| GPIO 113  | 4 | SPD1 CE55 P  | 3        | 243 | 244 |
| GPIO 114  | 4 | SPD1 CE56 N  | 3        | 245 | 246 |
| GPIO 115  | 4 | SPD1 CE56 P  | 3        | 247 | 248 |
| GPIO 116  | 4 | SPD1 CE57 N  | 3        | 249 | 250 |
| GPIO 117  | 4 | SPD1 CE57 P  | 3        | 251 | 252 |
| GPIO 118  | 4 | SPD1 CE58 N  | 3        | 253 | 254 |
| GPIO 119  | 4 | SPD1 CE58 P  | 3        | 255 | 256 |
| GPIO 120  | 4 | SPD1 CE59 N  | 3        | 257 | 258 |
| GPIO 121  | 4 | SPD1 CE59 P  | 3        | 259 | 260 |
| GPIO 122  | 4 | SPD1 CE60 N  | 3        | 261 | 262 |
| GPIO 123  | 4 | SPD1 CE60 P  | 3        | 263 | 264 |
| GPIO 124  | 4 | SPD1 CE61 N  | 3        | 265 | 266 |
| GPIO 125  | 4 | SPD1 CE61 P  | 3        | 267 | 268 |
| GPIO 126  | 4 | SPD1 CE62 N  | 3        | 269 | 270 |
| GPIO 127  | 4 | SPD1 CE62 P  | 3        | 271 | 272 |
| GPIO 128  | 4 | SPD1 CE63 N  | 3        | 273 | 274 |
| GPIO 129  | 4 | SPD1 CE63 P  | 3        | 275 | 276 |
| GPIO 130  | 4 | SPD1 CE64 N  | 3        | 277 | 278 |
| GPIO 131  | 4 | SPD1 CE64 P  | 3        | 279 | 280 |
| GPIO 132  | 4 | SPD1 CE65 N  | 3        | 281 | 282 |
| GPIO 133  | 4 | SPD1 CE65 P  | 3        | 283 | 284 |
| GPIO 134  | 4 | SPD1 CE66 N  | 3        | 285 | 286 |
| GPIO 135  | 4 | SPD1 CE66 P  | 3        | 287 | 288 |
| GPIO 136  | 4 | SPD1 CE67 N  | 3        | 289 | 290 |
| GPIO 137  | 4 | SPD1 CE67 P  | 3        | 291 | 292 |
| GPIO 138  | 4 | SPD1 CE68 N  | 3        | 293 | 294 |
| GPIO 139  | 4 | SPD1 CE68 P  | 3        | 295 | 296 |
| GPIO 140  | 4 | SPD1 CE69 N  | 3        | 297 | 298 |
| GPIO 141  | 4 | SPD1 CE69 P  | 3        | 299 | 300 |
| GPIO 142  | 4 | SPD1 CE70 N  | 3        | 301 | 302 |
| GPIO 143  | 4 | SPD1 CE70 P  | 3        | 303 | 304 |
| GPIO 144  | 4 | SPD1 CE71 N  | 3        | 305 | 306 |
| GPIO 145  | 4 | SPD1 CE71 P  | 3        | 307 | 308 |
| GPIO 146  | 4 | SPD1 CE72 N  | 3        | 309 | 310 |
| GPIO 147  | 4 | SPD1 CE72 P  | 3        | 311 | 312 |
| GPIO 148  | 4 | SPD1 CE73 N  | 3        | 313 | 314 |
| GPIO 149  | 4 | SPD1 CE73 P  | 3        | 315 | 316 |
| GPIO 150  | 4 | SPD1 CE74 N  | 3        | 317 | 318 |
| GPIO 151  | 4 | SPD1 CE74 P  | 3        | 319 | 320 |
| GPIO 152  | 4 | SPD1 CE75 N  | 3        | 321 | 322 |
| GPIO 153  | 4 | SPD1 CE75 P  | 3        | 323 | 324 |
| GPIO 154  | 4 | SPD1 CE76 N  | 3        | 325 | 326 |
| GPIO 155  | 4 | SPD1 CE76 P  | 3        | 327 | 328 |
| GPIO 156  | 4 | SPD1 CE77 N  | 3        | 329 | 330 |
| GPIO 157  | 4 | SPD1 CE77 P  | 3        | 331 | 332 |
| GPIO 158  | 4 | SPD1 CE78 N  | 3        | 333 | 334 |
| GPIO 159  | 4 | SPD1 CE78 P  | 3        | 335 | 336 |
| GPIO 160  | 4 | SPD1 CE79 N  | 3        | 337 | 338 |
| GPIO 161  | 4 | SPD1 CE79 P  | 3        | 339 | 340 |
| GPIO 162  | 4 | SPD1 CE80 N  | 3        | 341 | 342 |
| GPIO 163  | 4 | SPD1 CE80 P  | 3        | 343 | 344 |
| GPIO 164  | 4 | SPD1 CE81 N  | 3        | 345 | 346 |
| GPIO 165  | 4 | SPD1 CE81 P  | 3        | 347 | 348 |
| GPIO 166  | 4 | SPD1 CE82 N  | 3        | 349 | 350 |
| GPIO 167  | 4 | SPD1 CE82 P  | 3        | 351 | 352 |
| GPIO 168  | 4 | SPD1 CE83 N  | 3        | 353 | 354 |
| GPIO 169  | 4 | SPD1 CE83 P  | 3        | 355 | 356 |
| GPIO 170  | 4 | SPD1 CE84 N  | 3        | 357 | 358 |
| GPIO 171  | 4 | SPD1 CE84 P  | 3        | 359 | 360 |
| GPIO 172  | 4 | SPD1 CE85 N  | 3        | 361 | 362 |
| GPIO 173  | 4 | SPD1 CE85 P  | 3        | 363 | 364 |
| GPIO 174  | 4 | SPD1 CE86 N  | 3        | 365 | 366 |
| GPIO 175  | 4 | SPD1 CE86 P  | 3        | 367 | 368 |
| GPIO 176  | 4 | SPD1 CE87 N  | 3        | 369 | 370 |
| GPIO 177  | 4 | SPD1 CE87 P  | 3        | 371 | 372 |
| GPIO 178  | 4 | SPD1 CE88 N  | 3        | 373 | 374 |
| GPIO 179  | 4 | SPD1 CE88 P  | 3        | 375 | 376 |
| GPIO 180  | 4 | SPD1 CE89 N  | 3        | 377 | 378 |
| GPIO 181  | 4 | SPD1 CE89 P  | 3        | 379 | 380 |
| GPIO 182  | 4 | SPD1 CE90 N  | 3        | 381 | 382 |
| GPIO 183  | 4 | SPD1 CE90 P  | 3        | 383 | 384 |
| GPIO 184  | 4 | SPD1 CE91 N  | 3        | 385 | 386 |
| GPIO 185  | 4 | SPD1 CE91 P  | 3        | 387 | 388 |
| GPIO 186  | 4 | SPD1 CE92 N  | 3        | 389 | 390 |
| GPIO 187  | 4 | SPD1 CE92 P  | 3        | 391 | 392 |
| GPIO 188  | 4 | SPD1 CE93 N  | 3        | 393 | 394 |
| GPIO 189  | 4 | SPD1 CE93 P  | 3        | 395 | 396 |
| GPIO 190  | 4 | SPD1 CE94 N  | 3        | 397 | 398 |
| GPIO 191  | 4 | SPD1 CE94 P  | 3        | 399 | 400 |
| GPIO 192  | 4 | SPD1 CE95 N  | 3        | 401 | 402 |
| GPIO 193  | 4 | SPD1 CE95 P  | 3        | 403 | 404 |
| GPIO 194  | 4 | SPD1 CE96 N  | 3        | 405 | 406 |
| GPIO 195  | 4 | SPD1 CE96 P  | 3        | 407 | 408 |
| GPIO 196  | 4 | SPD1 CE97 N  | 3        | 409 | 410 |
| GPIO 197  | 4 | SPD1 CE97 P  | 3        | 411 | 412 |
| GPIO 198  | 4 | SPD1 CE98 N  | 3        | 413 | 414 |
| GPIO 199  | 4 | SPD1 CE98 P  | 3        | 415 | 416 |
| GPIO 200  | 4 | SPD1 CE99 N  | 3        | 417 | 418 |
| GPIO 201  | 4 | SPD1 CE99 P  | 3        | 419 | 420 |
| GPIO 202  | 4 | SPD1 CE100 N | 3        | 421 | 422 |
| GPIO 203  | 4 | SPD1 CE100 P | 3        | 423 | 424 |
| GPIO 204  | 4 | SPD1 CE101 N | 3        | 425 | 426 |
| GPIO 205  | 4 | SPD1 CE101 P | 3        | 427 | 428 |
| GPIO 206  | 4 | SPD1 CE102 N | 3        | 429 | 430 |
| GPIO 207  | 4 | SPD1 CE102 P | 3        | 431 | 432 |
| GPIO 208  | 4 | SPD1 CE103 N | 3        | 433 | 434 |
| GPIO 209  | 4 | SPD1 CE103 P | 3        | 435 | 436 |
| GPIO 210  | 4 | SPD1 CE104 N | 3        | 437 | 438 |
| GPIO 211  | 4 | SPD1 CE104 P | 3        | 439 | 440 |
| GPIO 212  | 4 | SPD1 CE105 N | 3        | 441 | 442 |
| GPIO 213  | 4 | SPD1 CE105 P | 3        | 443 | 444 |
| GPIO 214  | 4 | SPD1 CE106 N | 3        | 445 | 446 |
| GPIO 215  | 4 | SPD1 CE106 P | 3        | 447 | 448 |
| GPIO 216  | 4 | SPD1 CE107 N | 3        | 449 | 450 |

