TCE User Group Meeting – Memory Pooling

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- What's memory pooling? Any limitation/restriction when using memory pooling.
- Need to purchase special license for memory pooling?
- How to enable/disable the memory pooling feature?
- Can control the memory assignment within memory pool
- Can load more vectors than licensed memory ? What's the max vectors size that can be able to load?
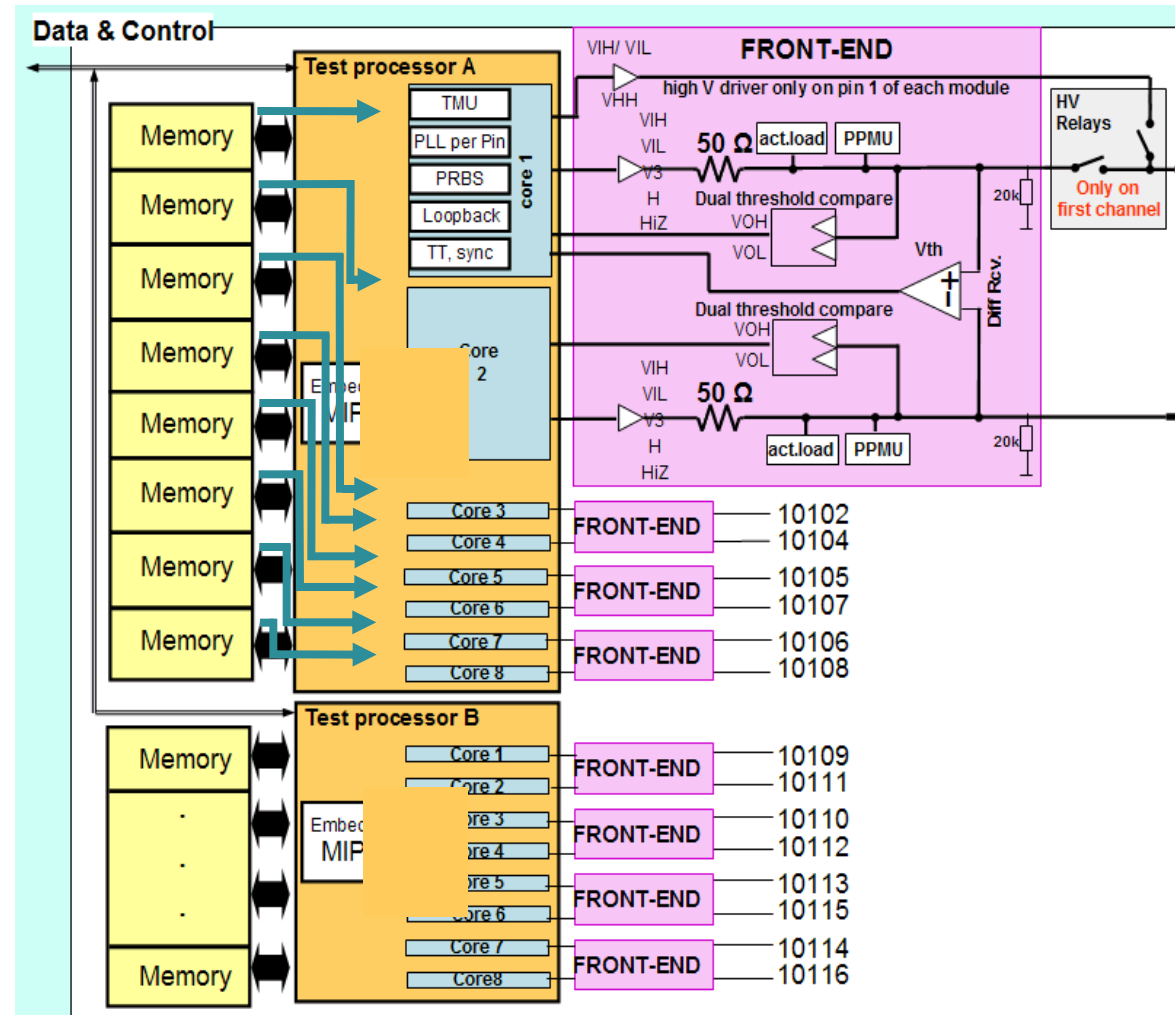
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Smart Scale solution provide a new memory management on PS1600 and PS9G Card.

- More flexible and increased vector memory
- High flexibility by Memory Pooling
  - 8* pins can freely access licensed vector memory
    - Deep scan pins up to 3.6GV (x4 mode) @ full I/O bandwidth
- Features are fully transparent to the user.

Memory Pooling

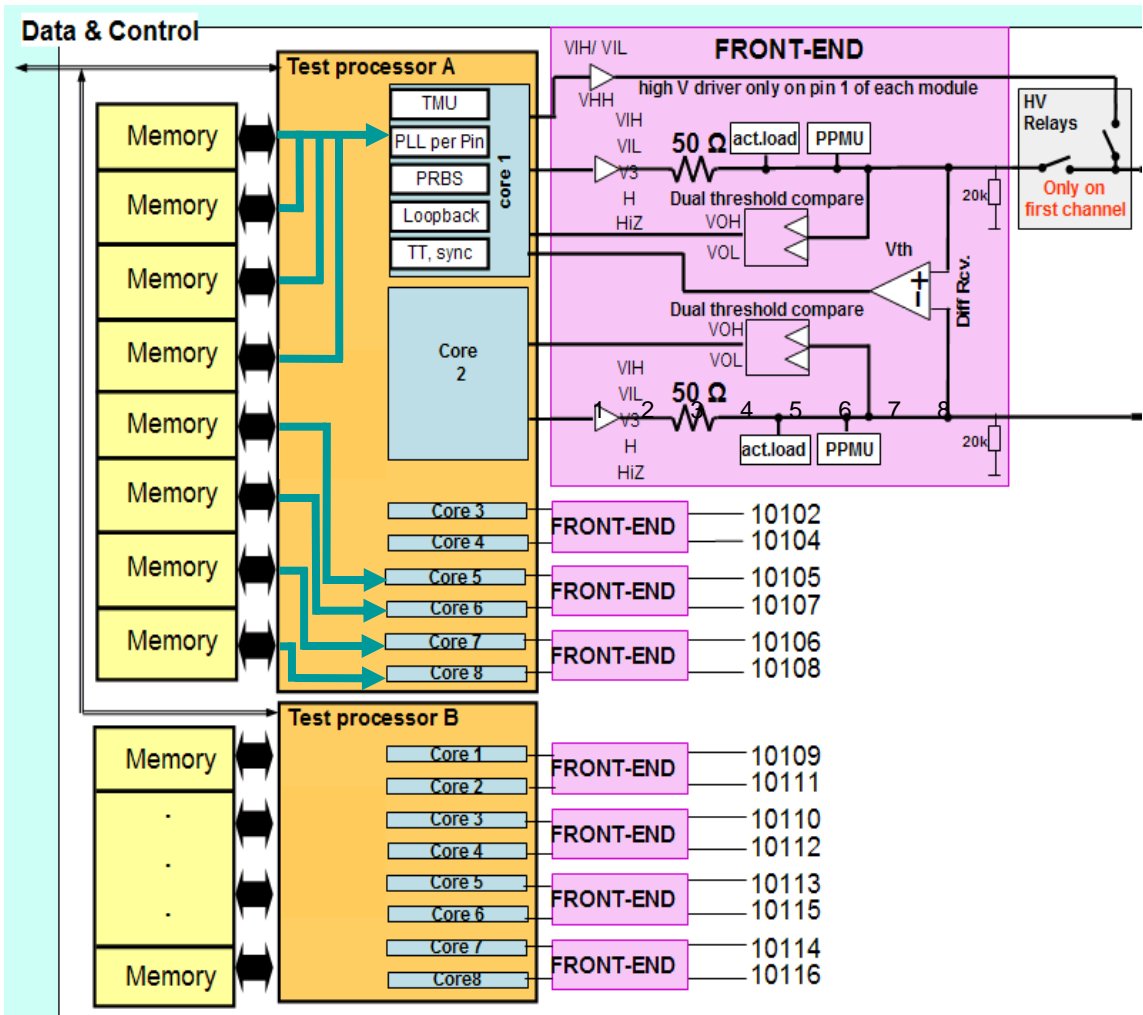1 2 3 4 5 6 7 8
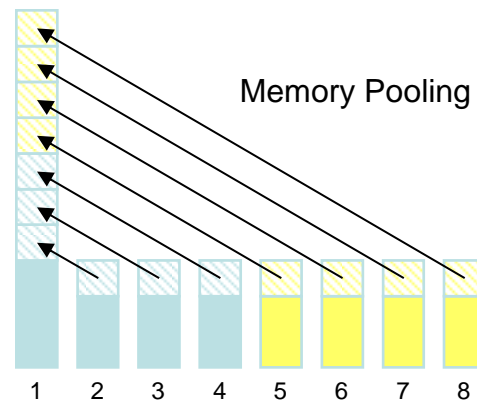
* 4 pins for PS9G due to different density

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•Test processor can distribute memory access

- Each pin has dedicated memory

- Multiple memories (or memory areas) are assigned to one pin.

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Memory Pooling Implementation

- <u>The Memory Pooling usage is transparent to the user</u>

  if a pin requires more vector memory than its license allows, the system checks automatically if this memory can be taken from the unused memory of the other pins inside the same Memory Pool and allocates it.

- <u>Example 1:</u>
- Let's suppose to have a Pin Scale 1600 card with 64MV memory license, and to load a 128 MV scan pattern into pin 10101.

Vector Memory

| 10101 |
| 10102 |
| 10103 |
| 10104 |
| 10105 |
| 10106 |
| 10107 |
| 10108 |

0.....16.....32......64... 112 MV
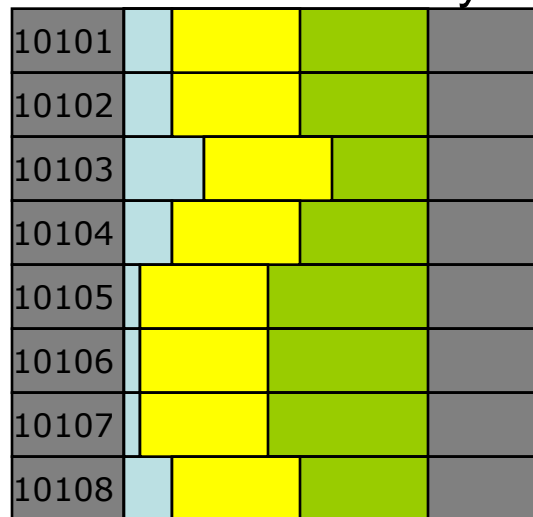
■ Licensed Memory
☐ Memory for functional pattern and DC
☐ Memory pool for scan pattern

The system check that 128MV cannot be contained in the memory of 10101 and that pooling is needed.
It pools 16M from each pin: 16x8=128M.

Memory from each pin can be flexibly used for both standard functional,DC pattern and as pool memory.

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To maximize the Vector Memory availability, Scan pins should be connected to the Pin Scale 1600 channels, distributing them evenly across the Pin Scale 1600 boards.

<u>Example 2</u>: Single Site DUT testing where each scan pin has been connected to a different 8-channel group

Max Memory available per Scan pin = 896MV (3.584GV)

Memory pool		
10101	→	**ScanIn0**
10102	→	non-scan pin
10103	→	non-scan pin
10104	→	non-scan pin
10105	→	non-scan pin
10106	→	non-scan pin
10107	→	non-scan pin
10108	→	non-scan pin

Memory pool		
10109	→	**ScanOut0**
10110	→	non-scan pin
10111	→	non-scan pin
10112	→	non-scan pin
10113	→	non-scan pin
10114	→	non-scan pin
10115	→	non-scan pin
10116	→	non-scan pin

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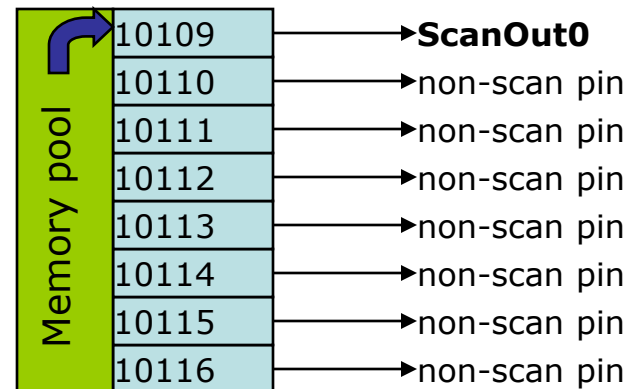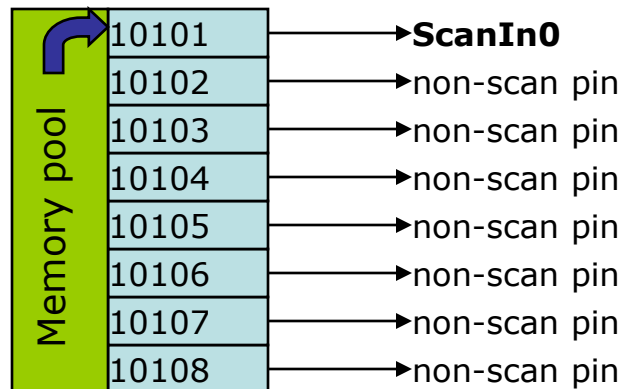
Defaults for Memory Pooling

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- Memory pooling is active by default (memory_pooling = ON).
  Model File Statement

-
```
'GLOBAL'

  memory_pooling = ON/OFF        #Enable/Disable the Memory Pooling and
                                  Sharing feature.
```

- In order to inactivate it, you must specify the following in the GLOBAL section of the model file:

  memory_pooling = OFF

- Memory assignment is controlled by Smartest.

- No license is required.

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- Memory Pooling is the capability for one pin to use memory of other pins which is licensed but not used.
    - The **Memory Pool** is the total amount of memory licensed for all the pins on a physical Test Processor (e.g. 10101-08).

    Max Allocable Memory per Pin (all pins with full memory license) :
    Pin Scale 1600 → 112M x 8 pins = 896M (3.584G x4 mode)

    - The following rule applies:

    "A pin can only get access to pool memory if its license is greater or equal than the one which is donating."

Example

0.....16.....32......64... 112 MV

■ Licensed Memory

1. Pins 10101 to 10104 can borrow memory from each other.

2. Pins 10101 to 10104 can <u>not</u> get memory from pins 10105 to 10108 because their licensed memory is smaller

3. Pins 10105 to 10108 can borrow memory from each other

4. Pins 10105 to 10108 can get memory from 10101 to 10104 because their licensed memory is bigger

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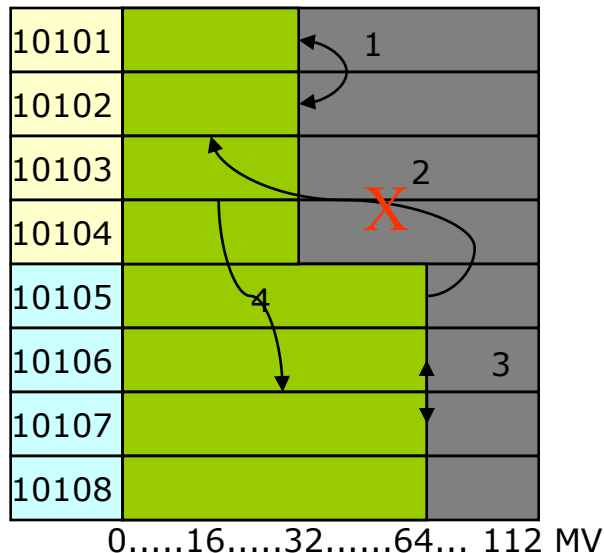
- Offline Smart test 7.1.4.7 workstation is used.
- Memory pooling can be turn ON/OFF in the model file.
- Aragorn X2 WS TP is used for this experiment.
- Setup involves numbers of io pins which required memory greater than 64M.
- Different Pattern Master files are created as different max vector required is 67M to 76M.
- Load the program with different model/license files for the different vector setups.
- Channel Mapping: gpio_14 -----------10701
-                               gpio_15 -----------10801
-                               gpio_31 -----------10702
-                               gpio_32 -----------10804
-                               gpio_33 -----------10803
-                               gpio_34 -----------10802
-                               mode_1 -----------10703

Memory Pooling Setup Examples (1)

- License greater than memory required. No issues.
- License is 112M, max vector is 67M.

```
             |           |          |         |    Speed    |
 Channel     |    HW     |   Speed  | Vectors |  Loopback   | misc
-------------+-----------+----------+---------+-------------+-------------------
 10101-22416 |   PS1600  | 1600 Mbps|   111M  |  1600 Mbps  | diff, tmu
```

Memory Usage is as expected on per channel basis:

Pin/Group/Chann	Used	Free	Total
10203	67 M	46 M	112 M
10304	67 M	46 M	112 M
10602	67 M	46 M	112 M
10703	67 M	46 M	112 M
10901	67 M	46 M	112 M
10902	67 M	46 M	112 M
10903	67 M	46 M	112 M
10904	67 M	46 M	112 M
11001	67 M	46 M	112 M
11002	67 M	46 M	112 M
11101	67 M	46 M	112 M

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Memory Pooling Setup Examples (2)

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- License less than memory required and Memory Pooling is OFF, vectors can't load successfully.
- License is 64M, max vector is 67M.

```
APG Speed:   0Mbps
Device Maintenance is:   OFF
Drive Edges:   8
Enhanced Edge Clock is: ON
Legacy Memory Test is: OFF
Memory Pooling is:   OFF
Memory Stacker is:   OFF
Port Scale RF 4x FE is:   OFF
Port Scale RF Power Amplifier Library is:   OFF
Protocol Aware is:   OFF
Pulldown in Level Set 0 is: ON
Receive Edges:   8
```

Error will be reported as not enough licensed memory available:

```
ERROR: VCAT - Not enough licensed memory available.
Error : (../vectors/PDF_limited/pdf_vpe_F79_288_svs100p_reg_X5.bin) : Failed to send a file to mcd
Error : (../vectors/ARAGORN_69.6M.pmf) Load pattern master file failed
```

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- License less than memory required and Memory Pooling is ON.
- License is 64M, required vector memory is 67M.

```
APG Speed:   0Mbps
Device Maintenance is:   OFF
Drive Edges:   8
Enhanced Edge Clock is: ON
Legacy Memory Test is: OFF
Memory Pooling is:   ON
Memory Stacker is:   OFF
Port Scale RF 4x FE is:   OFF
Port Scale RF Power Amplifier Library is:   OFF
Protocol Aware is:   OFF
Pulldown in Level Set 0 is: ON
Receive Edges:   8
```

Channels(10602,10901,10902,10903,10904…) will use max licensed memory and borrow from other channels within same group:

Pin/Group/Channel	Required	ParaMem used
10601	52 M	52 M
10602	67 M	64 M
10603	52 M	52 M
10604	52 M	52 M
10605	27 M	28 M
10606	28 M	28 M
10607	27 M	28 M
10608	28 M	28 M
10901	67 M	64 M
10902	67 M	64 M
10903	67 M	64 M
10904	67 M	64 M
10905	28 M	30 M
10906	27 M	30 M
10907	28 M	30 M
10908	27 M	30 M

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• Vectors is big enough (76M) to use up licensed memory and borrow all the memory from other channels.

```
             |            |             |           |   Speed       |
 Channel     |    HW      |    Speed    | Vectors   | Loopback      | misc
-------------+------------+-------------+-----------+---------------+--------------------
10101-10211  |   PS1600   |  100 Mbps   |    64M    | ---------     |
       10212 |   PS1600   |  533 Mbps   |    64M    | ---------     |
       10213 |   PS1600   |  100 Mbps   |    64M    | ---------     |
       10214 |   PS1600   |  533 Mbps   |    64M    | ---------     |
10215-10413  |   PS1600   |  100 Mbps   |    64M    | ---------     |
       10414 |   PS1600   |  100 Mbps   |    16M    | ---------     | diff
10415-10614  |   PS1600   |  100 Mbps   |    64M    | ---------     |
       10615 |   PS1600   |  100 Mbps   |    16M    | ---------     | diff
10616-10706  |   PS1600   |  100 Mbps   |    64M    | ---------     |
10707-10716  |   PS1600   |  100 Mbps   |    16M    | ---------     | diff
10801-10804  |   PS1600   |  100 Mbps   |    64M    | ---------     |
10805-10816  |   PS1600   |  100 Mbps   |    16M    | ---------     | diff
10901-11414  |   PS1600   |  100 Mbps   |    64M    | ---------     |
       11415 |   PS1600   |  100 Mbps   |    16M    | ---------     | diff
11416-11701  |   PS1600   |  100 Mbps   |    64M    | ---------     |
       11702 |   PS1600   |  533 Mbps   |    64M    | ---------     | tmu
       11703 |   PS1600   |  100 Mbps   |    64M    | ---------     |
       11704 |   PS1600   |  533 Mbps   |    64M    | ---------     |
       11705 |   PS1600   |  100 Mbps   |    64M    | ---------     |
       11706 |   PS1600   |  533 Mbps   |    64M    | ---------     |  |
```

Error will be reported as not enough memory available:

```
ERROR: VCAT - Not enough licensed memory available.
Error : (../vectors/PDF_limited/pdf_oxili_hm_SP_F95_550_tur0p_reg_X5.bin) : Failed to send a file to mcd
Error : (../vectors/ARAGORN_full_tdf.pmf) Load pattern master file failed
```

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Can borrow more memory from the other unused pins? Yes, no issue.
To do this, need enable this unused pins in device license file as below:

```
             |            |             |           |  Speed       |
  Channel    |    HW      |    Speed    | Vectors   |  Loopback    | misc
-------------+------------+-------------+-----------+--------------+-------------------
10101-10211  |   PS1600   |  100 Mbps   |    64M    |  --------- |
      10212  |   PS1600   |  533 Mbps   |    64M    |  --------- |
      10213  |   PS1600   |  100 Mbps   |    64M    |  --------- |
      10214  |   PS1600   |  533 Mbps   |    64M    |  --------- |
10215-10413  |   PS1600   |  100 Mbps   |    64M    |  --------- |
      10414  |   PS1600   |  100 Mbps   |    64M    |  --------- |
10415-10614  |   PS1600   |  100 Mbps   |    64M    |  --------- |
      10615  |   PS1600   |  100 Mbps   |    64M    |  --------- |
10616-10706  |   PS1600   |  100 Mbps   |    64M    |  --------- |
10707-10708  |   PS1600   |  100 Mbps   |    64M    |  --------- |
10801-10804  |   PS1600   |  100 Mbps   |    64M    |  --------- |
10805-10808  |   PS1600   |  100 Mbps   |    64M    |  --------- |
10901-11414  |   PS1600   |  100 Mbps   |    64M    |  --------- |
      11415  |   PS1600   |  100 Mbps   |    64M    |  --------- |
11416-11701  |   PS1600   |  100 Mbps   |    64M    |  --------- |
      11702  |   PS1600   |  533 Mbps   |    64M    |  --------- | tmu
      11703  |   PS1600   |  100 Mbps   |    64M    |  --------- |
      11704  |   PS1600   |  533 Mbps   |    64M    |  --------- |
      11705  |   PS1600   |  100 Mbps   |    64M    |  --------- |
```

Unused pins 10414,10615,10707-10708,10805-10808,11415 are added in device license file with min speed requirement and as large as possible memory size.

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Memory Pooling Setup Examples (5/2)

The big vectors(76M) master file can be loaded successfully, check memory usage:

Pin/Group/Channel	Required	ParaMem used
10414	0	0
10615	0	0
10701	76 M	64 M
10702	76 M	64 M
10703	76 M	64 M
10704	63 M	63 M
10705	27 M	27 M
10706	27 M	27 M
10707	0	17 M
10708	0	17 M
10801	76 M	64 M
10802	76 M	64 M
10803	76 M	64 M
10804	76 M	64 M
10805	0	12 M
10806	0	12 M
10807	0	12 M
10808	0	12 M
11415	0	0

Unused pins 10414,10615,11415 don't lend memory to other pins.
Unused pins 10707,10708 lend memory to pins(10701,10702,10703) within same group. Unused pins 10805,10806,10807,10808 lend memory to pins(10801,10802,10803,10804) within same group.

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Memory Pooling Setup Examples (6)

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- Restriction Violation. Channel 10701-10703,10801-10804 cannot borrow memory from other channels as they have lower memory license.

```
             |           |            |           |    Speed     |
  Channel    |    HW     |   Speed    | Vectors   |   Loopback   | misc
-------------+-----------+------------+-----------+--------------+-------------------
10101-10211  |  PS1600   |  100 Mbps  |    64M    |  ---------   |
      10212  |  PS1600   |  533 Mbps  |    64M    |  ---------   |
      10213  |  PS1600   |  100 Mbps  |    64M    |  ---------   |
      10214  |  PS1600   |  533 Mbps  |    64M    |  ---------   |
10215-10616  |  PS1600   |  100 Mbps  |    64M    |  ---------   |
10701-10703  |  PS1600   |  100 Mbps  |    32M    |  ---------   |
10704-10716  |  PS1600   |  100 Mbps  |    64M    |  ---------   |
10801-10804  |  PS1600   |  100 Mbps  |    32M    |  ---------   |
10805-11701  |  PS1600   |  100 Mbps  |    64M    |  ---------   |
      11702  |  PS1600   |  533 Mbps  |    64M    |  ---------   | tmu
      11703  |  PS1600   |  100 Mbps  |    64M    |  ---------   |
      11704  |  PS1600   |  533 Mbps  |    64M    |  ---------   |
      11705  |  PS1600   |  100 Mbps  |    64M    |  ---------   |
      11706  |  PS1600   |  533 Mbps  |    64M    |  ---------   |
      11707  |  PS1600   |  100 Mbps  |    64M    |  ---------   |
      11708  |  PS1600   |  533 Mbps  |    64M    |  ---------   |
      11709  |  PS1600   |  100 Mbps  |    64M    |  ---------   |
      11710  |  PS1600   |  200 Mbps  |    64M    |  ---------   |
```

- Error will be reported as channel 10701-10703,10801-10804 cannot load:

```
ERROR: VECC - Resize of vector area for port(s) ATPG_REG failed due to 'out of physical or licensed channel memory' on pin(s) gpio_14, gpio_15,
gpio_31, gpio_32, gpio_33, gpio_34, mode_1.
Error : (../vectors/ATPG/atpg_saf_lpc_se0_jpeg_reg_X5.bin) : Failed to send a file to mcd
Error : (../vectors/ARAGORN_full_tdf.pmf) Load pattern master file failed
```

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Summary

- Memory pooling feature make it possible to drive for deeper memory with limited licensed memory.
  - More vector memory on selected pins
  - Deeper vector memory on selected pins
  - More system vector memory distributed on multi site setups

- There are rules / restriction which applies to memory pooling.

- It's very easy to use the memory pooling feature of PS1600/PS9G, however, it need to pay attention to channels assignment and use it smartly in order to get as max as possible vector memory.

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THANK YOU!

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