AN4557
Application note

Introduction to the usage of TDM peripheral SPC57xx devices

Introduction

A new topic is arising in the automotive world: how to avoid protection breaches and prevent security violations by eavesdroppers. Undetected tampering is one of these security threats. Tampering means improper alteration of sensible data inside the car ecosystem, for example unauthorized firmware modification, illegal calibration data adjustment, illicit odometer data gaining and so forth.

Undetected tampering can cause loss of income for vehicle makers (when a new firmware is installed without authorization) till even serious injuries (e.g. a software virus may disable the ABS or block the throttle device, the steering and so on).

The SPC57xx embeds different layers to protect from these security menaces.

The aim of this application note is to describe one of these layers to properly protect the flash from undetected tampering by using the "Tamper Detection Module", i.e. TDM.

The TDM module is used to associate an erase operation with a signature written into a “diary”. Every time the flash is erased, a signature has to be saved in the log. The signature is user-dependent.

TDM is mainly configured by some writing DCF records in the UTest flash memory.

In order to speed up the usage of this module, a reference code has been used as example.

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1 Overview

The TDM provides a protection mechanism of Flash memory that forces software to write a record associated with one or more blocks in a Tamper Detection Region (TDR) before the block(s) can be erased.

TDM requires a record to be written to a specified Flash area before the erase operation can be executed. Collectively, the records are referred to as a “diary”.

The content of the diary is defined by the user. It may serve as a simple erase counter or it may contain more advanced details for example a journal to log erase details like who is erasing, checksum of the Flash content and so forth.

Up to 6 TDRs can be defined via DCF records.

1.1 Diary

The diary is a region of Flash memory where records[a] of block erases for each TDR are stored. The device implements 6 TDRs. Each TDR consists of 256 × 64-bit records to store until 256 attempts of erasing of Flash blocks assigned to each TDR.

Erasing of any block within a TDR is not protected by the TDM. To avoid malicious erasing of the diary, the diary should reside in a Flash block that is assigned as OTP[b].

This means that at least one block of Flash memory, which is allocated to the TDR, shall be configured as OTP. Once done, such assigning can’t be removed. Customer can choose any Flash memory sector to be assigned to the TDR, but one of the low 16KB blocks is a good solution in terms of size.

The format and size of these records are defined by the user. The only hardware constraints are:

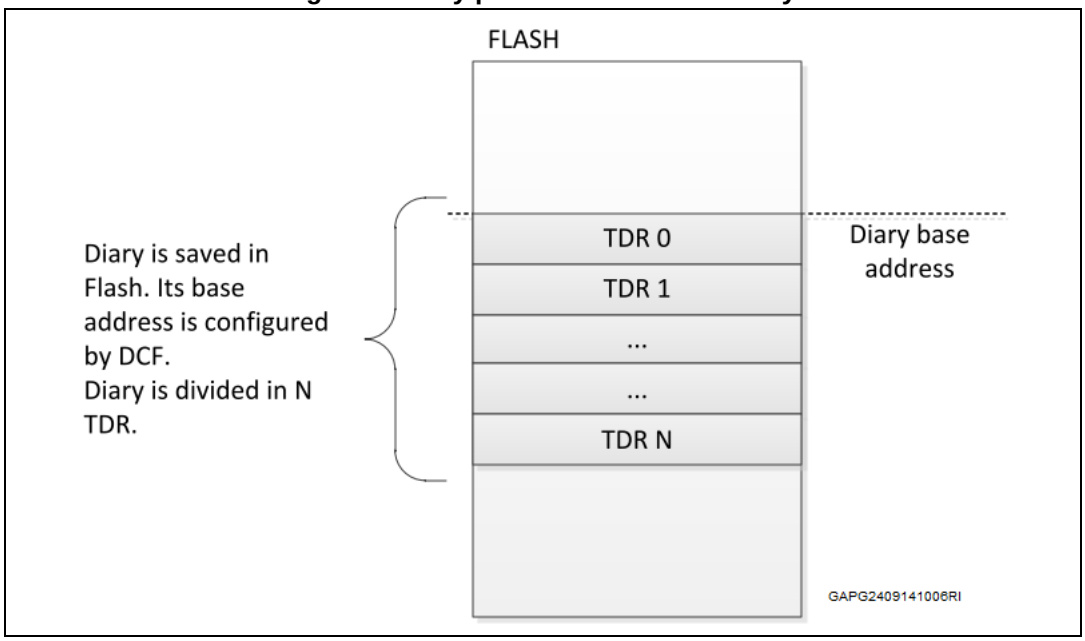
- each diary has a maximum size of 2 KB, and
- the minimum size of any programming operation is 8 bytes.

With 6 TDR the maximum overall size of the diary is 12 KB, as shown in *Figure 1*.

a. Records contain user-dependent details about each erase.

b. User shall use the DCF record called OTP_ENx to configure a Flash block as OTP.

Figure 1. Diary position in Flash Memory



Warning: The diary base address must be at a 16KB boundary. Therefore the least significant 14 bits of the Diary base address must all be '0'.

1.2 DCF client

It is important to understand the role of DCF records and DCF clients and how they affect TDM functions.

DCF records contain configuration data processed during device boot. Those records are permanently stored in a dedicated block of on-chip Flash memory, i.e. UTest sector. TDM-related DCF records configure the following parameters:

- Establish a permanent diary base address
- Define Tamper Detect Regions (TDRs) to monitor on-chip Flash memory program/erase activity
- Permanently disable one or more Tamper Regions
- Configure Flash memory as One Time Programmable (OTP) on a per-block basis

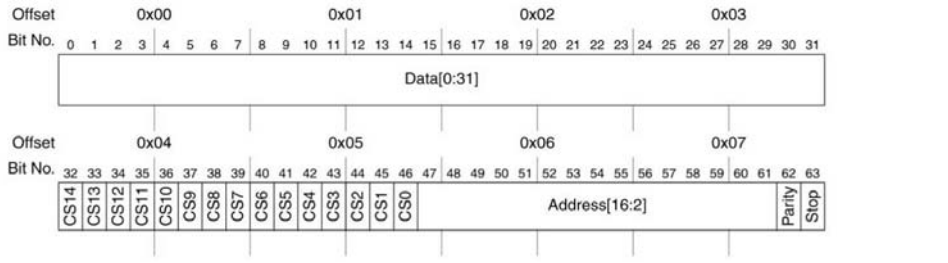
A DCF client is an internal register within a module that corresponds to a specific type of DCF record. Although multiple instances of a DCF record type may exist, but if they are considered valid depends on the strategy associated with that record type. For example:

- if it is defined "write once" and multiple instances are created, only the first one will be processed, or
- if it is defined "write 1 only", bits can be changed only from 0 to 1.

1.2.1 DCF client structure

All the DCF records have a common structure. They appear as contiguous double-word (64-bit) entries programmed in a reserved area of OTP UTEST Flash memory beginning at 0x0040_0200.

Figure 2. DCF structure



The Data[0:31] holds the value to write, CS[0:14] represents the Chip Select assigned during chip definition, Address[16:2] holds the value of the DCF address, relevant only to the address decoding within that module. Parity is not implemented in DCF record written in UTEST, while Stop bit indicates the end of the DCF records list.

The Tamper Detection Module implements the following DCF records that are saved in the UTest Flash memory:

Table 1. DCF of TDM in UTest Flash memory

DCF client description	Reset value	DCF client Special Strategy	Value to write in the Utest (example) = Value to write(1) | Chip Select | DCF Address	Chip Select	DCF Address
Diary Base Address	0xffff_ffff	Write Once + Write ‘0’ only	0xXXXX_XXXX_0020_0000	0x0020_0000	0x0
Tamper Region Override	0x00	Write Once + Write ‘1’ only	0xXXXX_XXXX_0020_0004	0x0020_0000	0x4
OTP_EN0	0x0000_0000	Write Once + Write ‘1’ only	0xXXXX_XXXX_0020_0020	0x0020_0000	0x20
OTP_EN1	0x0000_0000	Write Once + Write ‘1’ only	0xXXXX_XXXX_0020_0024	0x0020_0000	0x24
OTP_EN2	0x0000_0000	Write Once + Write ‘1’ only	0xXXXX_XXXX_0020_0028	0x0020_0000	0x28
OTP_EN3	0x0000_0000	Write Once + Write ‘1’ only	0xXXXX_XXXX_0020_002C	0x0020_0000	0x2C
TDR0_LOCK0	0x0000_0000	Write Once + Write ‘1’ only	0xXXXX_XXXX_0020_0050	0x0020_0000	0x50
TDR0_LOCK1	0x0000_0000	Write Once + Write ‘1’ only	0xXXXX_XXXX_0020_0054	0x0020_0000	0x54

Table 1. DCF of TDM in UTest Flash memory (continued)

DCF client description	Reset value	DCF client Special Strategy	Value to write in the Utest (example) = Value to write(1) | Chip Select | DCF Address	Chip Select	DCF Address
TDR0_LOCK2	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0058	0x0020_0000	0x58
TDR0_LOCK3	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_005C	0x0020_0000	0x5C
TDR1_LOCK0	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0060	0x0020_0000	0x60
TDR1_LOCK1	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0064	0x0020_0000	0x64
TDR1_LOCK2	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0068	0x0020_0000	0x68
TDR1_LOCK3	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_006C	0x0020_0000	0x6C
TDR2_LOCK0	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0070	0x0020_0000	0x70
TDR2_LOCK1	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0074	0x0020_0000	0x74
TDR2_LOCK2	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0078	0x0020_0000	0x78
TDR2_LOCK3	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_007C	0x0020_0000	0x7C
TDR3_LOCK0	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0080	0x0020_0000	0x80
TDR3_LOCK1	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0084	0x0020_0000	0x84
TDR3_LOCK2	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0088	0x0020_0000	0x88
TDR3_LOCK3	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_008C	0x0020_0000	0x8C
TDR4_LOCK0	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0090	0x0020_0000	0x90
TDR4_LOCK1	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0094	0x0020_0000	0x94
TDR4_LOCK2	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_0098	0x0020_0000	0x98
TDR4_LOCK3	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_009C	0x0020_0000	0x9C

Table 1. DCF of TDM in UTest Flash memory (continued)

DCF client description	Reset value	DCF client Special Strategy	Value to write in the Utest (example) = Value to write(1) | Chip Select | DCF Address	Chip Select	DCF Address
TDR5_LOCK0	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_00A0	0x0020_0000	0xA0
TDR5_LOCK1	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_00A4	0x0020_0000	0xA4
TDR5_LOCK2	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_00A8	0x0020_0000	0xA8
TDR5_LOCK3	0x0000_0000	Write Once + Write '1' only	0xXXXX_XXXX_0020_00AC	0x0020_0000	0xAC

1. Application depended. Here is left with 0xXXXX_XXXX.

Hereafter the list of DCF records associated to the TDM, which are saved by the example *Figure 10: All PASS's passwords are set to 0x5555_5555 (part 1)* and *Figure 11: All PASS's passwords are set to 0x5555_5555 (part 2)* into the UTest:

- *SET_DCF_DBA = (0x00FC_4000_0020_0000)*
  in order to choose the Low Block 2 of Flash memory
- *SET_DCF_OTPEN0 = (0x0004_0000_0020_0020)*
  in order to set OTP the Low Block 2
- *SET_DCF_TDR0_LOCK0 = (0x0008_0000_0020_0050)*
  in order to assign the Low Block 3 to the diary
- *SET_DCF_TR0 = (0x0000_003F_0020_0004)*
  in order to override all the TDR Locks DCF.

Figure 3. TDM DCF records involved in the application code

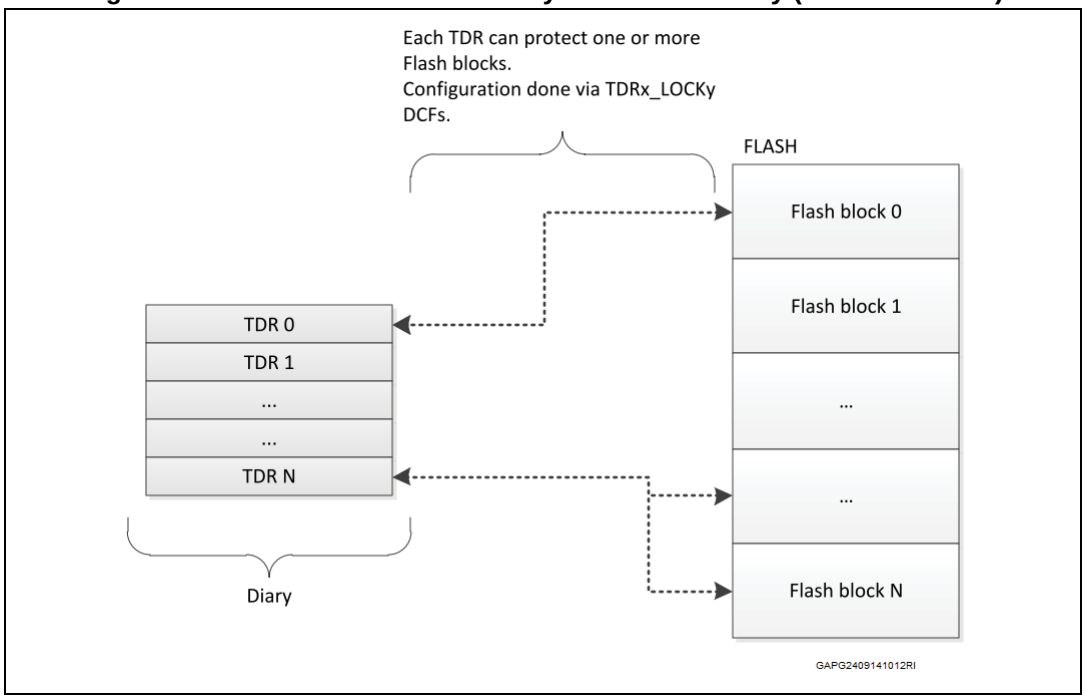
```
&UTEST_DCF_base=0x00400308
        &current_address=&UTEST_DCF_base

        ;1   -   SET_CENSORSHIP 0x55AA
        &current_address=&current_address
        GOSUB program_word &current_address 0x000055AA001000B0

        ;2   -   SET_DCF_DBA 0x00FC4000
        &current_address=&current_address+0x8
        GOSUB program_word &current_address 0x00FC400000200000

        ; 3  -   SET_DCF_OTPEN0 0x00040000   OTPEN0 Low Block2 OTP
        ; affects flash memory blocks in Low address space.
        &current_address=&current_address+0x8
        GOSUB program_word &current_address 0x0004000000200020

        ;4   -   SET_DCF_TDR0_LOCK0 0x00080000 (Low Block3 Tamper Region              Assignment)
        Low block 3 is assigned to TDR0. (0x00FC8000)
        &current_address=&current_address+0x8
        GOSUB program_word &current_address 0x0008000000200050

        ;5   -   SET_DCF_TDR0 0x0000003F    (Diary override)
        &current_address=&current_address
        GOSUB program_word &current_address 0x0000003F00200004

        program_word:
            entry &address &data

            PER.S ANC:0xFFFE0000 %LONG 0x610     ;MCR->PGM =1 enable program memory
             D.S EA:(&address) %BE %QUAD (&data)
            print      "written = 0x" &address
            PER.S  ANC:0xFFFE0000 %LONG 0x611          ;MCR->EHV=1 program memory
            WHILE ((Data.Long(      ea:0xFFFE0000)&0x0200)==0);       ;while (FLASH.MCR.B.DONE == 0);

            PER.S ANC:0xFFFE0000 %LONG 0x610          ;MCR->EHV=0 program memory
            PER.S ANC:0xFFFE0000 %LONG 0x600          ;MCR->PGM =0

        RETURN
```

GAPG1707141240RI

1.3 How to link Flash sector to a diary

The mechanism to link a specific Flash memory sector to the diary is based on the TDRx_LOCKy DCF clients. Those DCF clients assign a Flash block to a specific Diary. See the Device-Specific Chapter" of the RM for the mapping between field bits of the TDRx_LOCKy DCF clients and Flash blocks. The same mapping also applies to similar functions in the embedded Flash memory module, for example password protection via PASS module.

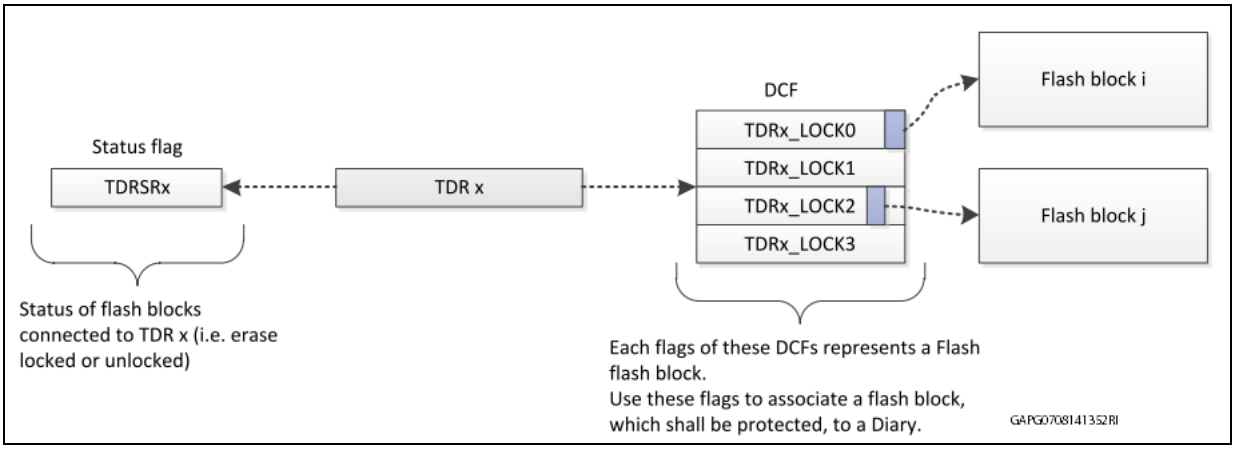
Figure 4. Link between Flash memory sectors and diary (TDR Number=6)



Warning: No Flash block should be assigned to more than one TDR. Each Flash block should correspond to a single TDR. For example, if a single Flash block is assigned to TDR0 and TDR1, it will never be unlocked for erase operation even if the Diary is program

TDM provides a read-only register to read the status of the Flash blocks linked to a specific TDR. As shown in *Figure 5*, this register reflects the status flag associated to the TDRx_LOCKy DCF to lock/unlock the chosen Flash Block.

Figure 5. TDRSR status flag Vs Diary and TDRxLOCKy DCF



Warning: EEPROM memory cannot be protected by TDM module.

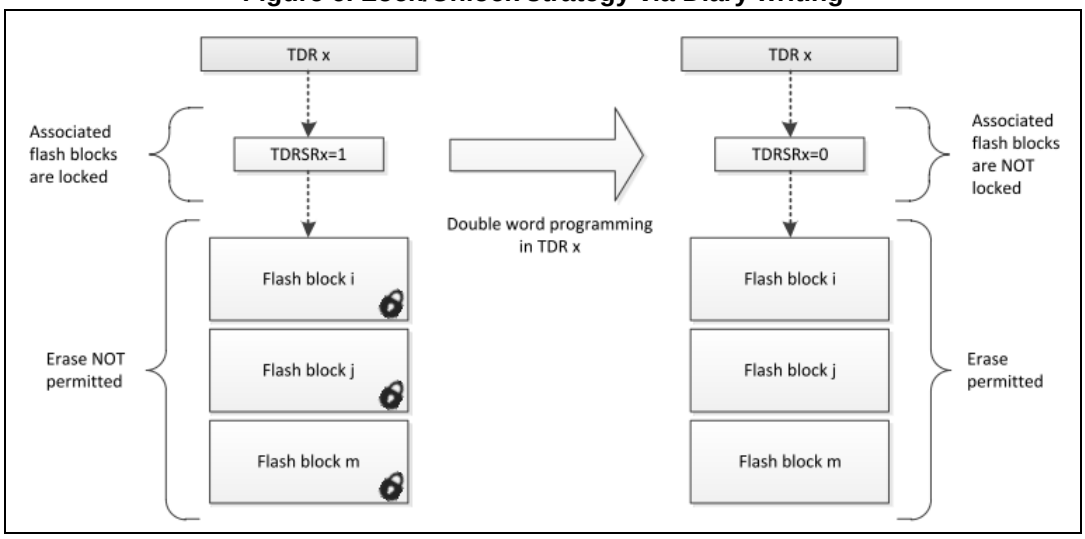
1.4 Lock/Unlock strategy via TDM

Once the user has

1. programmed the right DCFs in order to set the Diary Base Address (DBA),
2. set the relative bit for TDRx_LOCKy to choose the Flash sector to be protected, and
3. trigger a reset specified Flash sectors are protected from tampering.

The only way to erase[c] this Flash sector is to write a double word in the TDR as described in *Figure 6*.

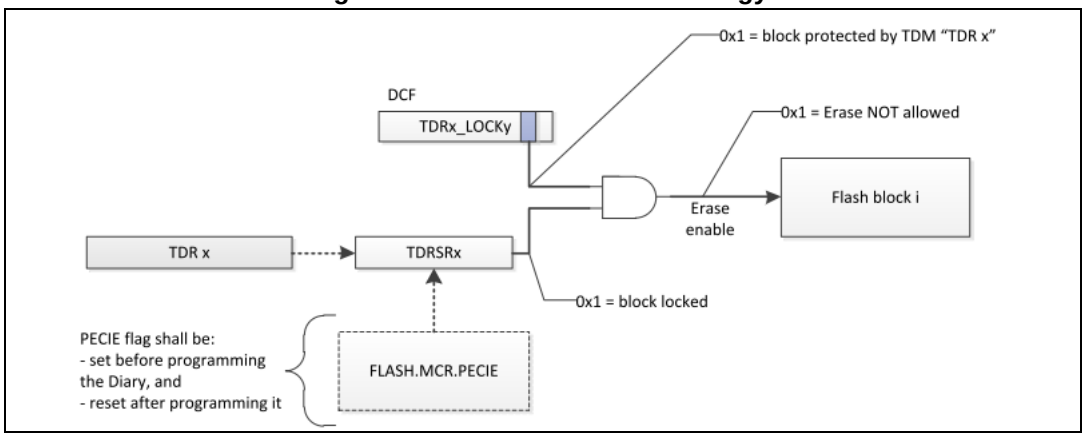
Figure 6. Lock/Unlock strategy via Diary writing



The Erase Flash Block strategy shows a high level schema of signals involved in TDM protection, which have to be set in order to unlock the erase Flash block protection. For sake of simplicity, OTP flags, lock password protection and region R/W protection from PASS module have not been considered.

c. TDM monitors erase operation only. User can over-program a Flash sector which is locked by the TDM (in this case, user shall take care of the potential injection of ECC error in the Flash array). Other security layers are available, e.g. PASS module, to protect from over-programming.

Figure 7. Erase Flash Block strategy



Warning: ***For SPC574K72xx device, user shall set the Program/Erase Complete Interrupt Enable (PECIE) bit in the Flash Module Configuration Register (MCR) before doing any Flash block erase operation which includes TDM diary update operation. The PECIE interrupt does not need to be processed by the Interrupt controller. To prevent the interrupt from being processed its priority should be left at the default of 0 within the Interrupt controller. See Errata ERR008089.***

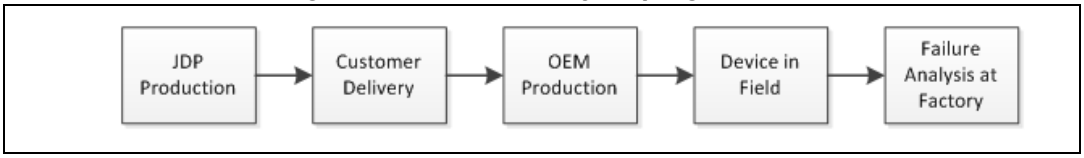
1.5 Life cycle configuration

Five states, called Life Cycles, are defined in SPC57xx devices. These working states represent a device maturity model (see *Figure 8*). The behavior of the device depends on its Life Cycle. The list of life cycles is:

- ST Production
  No security implemented
- Customer delivery[(d)]
  Very limited security to guarantee the ECU development
- OEM production
  Limited security to guarantee the ECU development
- In Field
  Full security
- Failure analysis
  Limited security to guarantee the protection of critical data but also the testability. The unit can´t be run In Field any more.

d. Samples are shipped by ST with Life Cycle set as Customer Delivery.

Figure 8. SPC57xx life cycle progression



Section “Life cycle truth table” of the Security Manual gives all needed details on security and lifecycle.

To advance the life cycle to OEM, the user shall write in the UTest sector starting from the address 0x0040_0208, four double words equal to 0x55AA_50AF_55AA_50AF (refer to section Life Cycle in SSCM chapter of the reference manual to have all additional details).

In the following example a debugger script has been used to program the UTest Flash in order to move the Life Cycle from Customer delivery to OEM production.

Figure 9. DCF record to advance the life cycle from “customer delivery” to “OEM production”

```
&UTEST_DCF_LIFE_CYCLE=0x00400208
        &current_address=&UTEST_DCF_LIFE_CYCLE

        ;1  -  UTEST_DCF_LIFE_CYCLE 55AA_50AF_55AA_50AF to pass to      Customer delivery
        &current_address=&current_address
        GOSUB program_word &current_address 0x55AA50AF55AA50AF

        ;2  -  UTEST_DCF_LIFE_CYCLE 55AA_50AF_55AA_50AF
        &current_address=&current_address+0x8
        GOSUB program_word &current_address 0x55AA50AF55AA50AF

        ;3  -  UTEST_DCF_LIFE_CYCLE 55AA_50AF_55AA_50AF to pass to OEM production
        &current_address=&current_address+0x8
        GOSUB program_word &current_address 0x55AA50AF55AA50AF

        ;4  -  UTEST_DCF_LIFE_CYCLE 55AA_50AF_55AA_50AF
        &current_address=&current_address+0x8
        GOSUB program_word &current_address 0x55AA50AF55AA50AF

                                                                GAPG2309141137RI
```

Warning: For example the PASS module is activated in OEM production. This feature has a strong impact on the security. More details in the next section.

Figure 9 shows an example of DCF records on which JTAG passwords and all PASS passwords are set to 0x5555_5555.

1.6 PASS module and life cycle

PASS module is automatically activated starting from the OEM live cycle. It provides password comparison to protect access via JTAG and program/erase operations on Flash sectors.

User shall define 5 passwords of 256bit. If the user doesn't provide these passwords, PASS module can gate debug and Flash operations. These passwords are configured via DCF records. It's very important to set them before, or concurrently, moving the lifecycle to "OEM production".

Have a look at the section "Password and Device Security Module (PASS)" of the reference manual to have all needed details on using the PASS module.

Warning: If the device is moved to the OEM lifecycle without knowing the PASS passwords, the specific samples can't be accessed anymore and Flash can't be programmed/erased.

Figure 9 shows an example of DCF records on which JTAG passwords and all PASS passwords are set to 0x5555_5555.

Figure 10. All PASS's passwords are set to 0x5555_5555 (part 1)

```
&UTEST_DCF_JTAG_PASS=0x00400120
        &current_address=&UTEST_DCF_JTAG_PASS

  IF &progflash
  (

        ;Lock0    - >TSLock enable UTEST memory
         PER.S ANC:0xFFFE0010 %LONG 0x3FFFFFFF

        ;1   -   SET_DCF_JTAG_PASS 0x55555555   0x55555555
        GOSUB program_word &current_address 0x5555555555555555

        ;2   -   SET_DCF_JTAG_PASS 0x55555555   0x55555555
        &current_address=&current_address+0x8
        GOSUB program_word &current_address 0x5555555555555555

        ;3   -   SET_DCF_JTAG_PASS 0x55555555   0x55555555
        &current_address=&current_address+0x8
        GOSUB program_word &   current_address 0x5555555555555555

        ;4   -   SET_DCF_JTAG_PASS 0x55555555   0x55555555
        &current_address=&current_address+0x8
        GOSUB program_word &current_address 0x5555555555555555

        ;1   -   SET_DCF_PASS_PASSWORD 0x55555555   0x55555555
        &current_address=&cur       rent_address+0x8
        GOSUB program_word &current_address 0x5555555555555555

        ;2   -   SET_DCF_PASS_PASSWORD 0x55555555   0x55555555
        &current_address=&current_address+0x8
        GOSUB program_word &current_address 0x5555555555555555

        ;3   -   SET_DCF_PASS_PASSWORD 0x55555555   0x55555555
        &current_address=&current_address+0x8
        GOSUB program_word &current_address 0x5555555555555555

        ;4   -   SET_DCF_PASS_PASSWORD 0x55555555   0x55555555
        &current_address=&current_address+0x8
        GOSUB program_word &current_address          0x5555555555555555

        ;1   -   SET_DCF_PASS_PASSWORD 0x55555555   0x55555555
        &current_address=&current_address+0x8
        GOSUB program_word &current_address 0x5555555555555555

        ;2   -   SET_DCF_PASS_PASSWORD 0x55555555   0x55555555
        &current_address=&      current_address+0x8
        GOSUB program_word &current_address 0x5555555555555555
```

Figure 11. All PASS's passwords are set to 0x5555_5555 (part 2)

```
;3   -  SET_DCF_PASS_PASSWORD 0x55555555  0x55555555
&current_address=&current_address+0x8
GOSUB program_word &current_address 0x5555555555555555

;4   -  SET_DCF_PASS_PASSWORD 0    x55555555  0x55555555
&current_address=&current_address+0x8
GOSUB program_word &current_address 0x5555555555555555

;1   -  SET_DCF_PASS_PASSWORD 0x55555555  0x55555555
&current_address=&current_address+0x8
GOSUB program_word &current_address 0x555555              5555555555

;2   -  SET_DCF_PASS_PASSWORD 0x55555555  0x55555555
&current_address=&current_address+0x8
GOSUB program_word &current_address 0x5555555555555555

;3   -  SET_DCF_PASS_PASSWORD 0x55555555 0x55555555
&current_address=&current_address+0x8
GOSUB program_word &current_address 0x5555555555555555

;4   -  SET_DCF_PASS_PASSWORD 0x55555555  0x55555555
&current_address=&current_address+0x8
GOSUB program_word &current_address 0x5555555555555555

;1   -  SET_DCF_PASS_PASSWORD 0x55555555  0x5555555          5
&current_address=&current_address+0x8
GOSUB program_word &current_address 0x5555555555555555

;2   -  SET_DCF_PASS_PASSWORD 0x55555555  0x55555555
&current_address=&current_address+0x8
GOSUB program_word &current_address 0x5555555555555555

;3   -  SE T_DCF_PASS_PASSWORD 0x55555555  0x55555555
&current_address=&current_address+0x8
GOSUB program_word &current_address 0x5555555555555555

;4   -  SET_DCF_PASS_PASSWORD 0x55555555  0x55555555
&current_address=&current_address+0x8
GOSUB program_word &     current_address 0x5555555555555555
```

Once the PASS module is activated, the debugger shall provide the right passwords before erasing/programming the Flash.

Figure 12 shows the flow to implement the procedure to unlock Flash operations. It shall be done for all 4 password groups defined in the PASS module.

Figure 13 shows an extract of code used to remove the lock for all PASS groups.

Figure 12. Flow to unlock Flash programming/erasing via PASS module

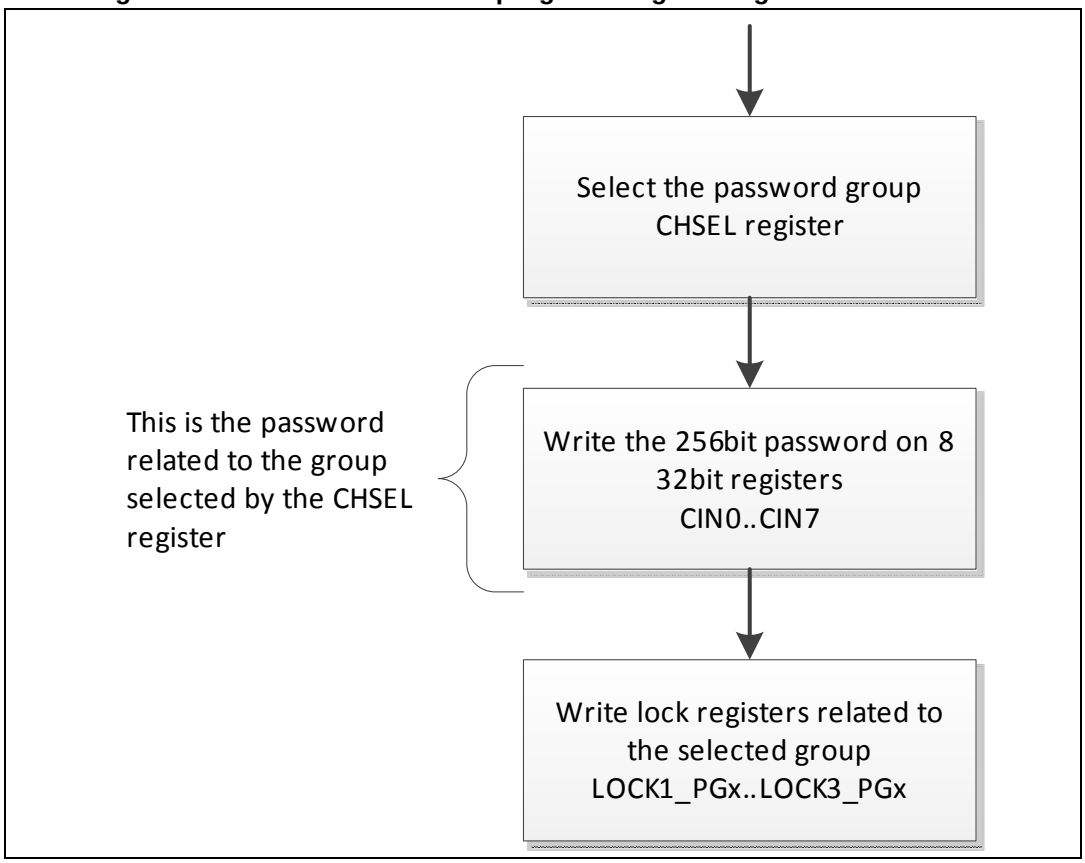


Figure 13. Application code to remove the PASS lock

```
void    Unlock_Flash()
{
      uint8_t      i;

          PASS.CHSEL.B.GRP =          0;     /* Unlock password group #0 */

          for (i=      0; i<    8; i++)
          {
                    PASS.CIN[i].B.PW32 =            0x55555555   ;   /* set the right password (same in
DCF) */
          }

          PASS.TIMER[     0].LOCK   0_PG.R =     0x0;   /* Unlock LOCK0_PG0 */
          PASS.TIMER[     0].LOCK1_PG.R =        0x0;   /* Unlock LOCK0_PG1 */
          PASS.TIMER[     0].LOCK2_PG.R =        0x0;   /* Unlock LOCK0_PG2 */
          PASS.TIMER[     0].LOCK3_PG.R =        0x0;   /* Unlock LOCK0_PG3 */

          PASS.CHSEL.B.GRP =          1;     /* Unlock password group #1 */

          for (i=      0; i<    8; i++)
          {
                    PASS.CIN[i].B.PW32 =            0x55555555   ;   /* set the right password (same in
DCF) */
          }

           PASS.TIMER[     1].LOCK0_PG.R =        0x0 ;   /* Unlock LOCK0_PG0 */
          PASS.TIMER[     1].LOCK1_PG.R =        0x0 ;   /* Unlock LOCK0_PG1 */
          PASS.TIMER[     1].LOCK2_PG.R =        0x0 ;   /* Unlock LOCK0_PG2 */
          PASS.TIMER[     1].LOCK3_P    G.R =    0x0 ;   /* Unlock LOCK0_PG3 */

          PASS.CHSEL.B.GRP =          2;     /* Unlock password group #2 */

          for (i=      0; i<    8; i++)
          {
                    PASS.CIN[i].B.PW32 =            0x55555555   ;   /* set the right password (same in
DCF) */
          }

          PASS.TIMER[     2].LOCK0_PG.R =        0x0 ;   /* Unlock LOCK0_PG0 */
          PASS.TIMER[     2].LOCK1_PG.R =        0x0 ;   /* Unlock LOCK0_PG1 */
          PASS.TIMER[     2].LOCK2_PG.R =        0x0 ;   /* Unlock LOCK0_PG2 */
          PASS.TIMER[     2].LOCK3_PG.R =        0x0 ;   /* Unlock LOCK0_PG3 */

          PASS.CHSEL.B.GRP =          3;     /* Unlock password group #3 */

          for (i=      0; i<    8; i++)
          {
                    PASS.CIN[i].B.PW32 =            0x55555555   ;   /* set the right password (same in
DCF) */
          }

          PASS.TIMER[     3].LOCK0_PG.R =        0x0 ;   /* Unlock LOCK0_PG0 */
          PASS.TIMER[     3].LOCK1_PG.R =        0x0 ;   /* Unlock LOCK0_PG1 */
          PASS.TIMER[     3].LOCK2_PG.R =        0x0 ;   /* Unlock LOCK0_PG2 */
          PASS.T    IMER[  3].LOCK3_PG.R =       0x0 ;   /* Unlock LOCK0_PG3 */

          FLASH.LOCK0.R =       0x0 ;     /* unlock flash */
          FLASH.LOCK1.R =       0x0 ;     /* unlock flash */
          FLASH.LOCK2.R =       0x0 ;     /* unlock flash */
}                                                                                    GAPG0310141141RI
```

1.7 Override

Once the diary is full the user can decide to override the TDM protection to allow the erase operations without limitation given by the TDM or may choose to stop further erase operations.

Diary override mechanism is implemented with a DCF client consisting of 6 bits, one for each TDR.

In order to override the TDM protection the TO (Tamper Override) DCF client has to be programmed by the relative bitfield with 1. Any attempt to write bits from 1 to 0 is ignored, this means that the override process is permanent.

2 Summary

This overview of the TDM describes one of the security layers embedded in the SPC57xx family microcontroller. The TDM can disable the erase operation of Flash memory sectors until a “digital sign” is written in the “diary”

Content of the diary is user-dependent, from a simple counter of erasing operation to an erase log.

This application note summarizes the key points to configure the TDM to start automatically after the reset.

To speed up the implementation of such configuration, a reference code is provided. Reference code is described on *Section Appendix A*.

Appendix A Reference code

Reference code[e] associated to this document shows how to configure TDM automatically via DCF. If the device is configured correctly, once that debugger script is loaded, the following scenario is set:

- PASS password, JTAG passwords are set to 0x5555_5555 (see *Figure 9: DCF record to advance the life cycle from "customer delivery" to "OEM production"*)
- Device is uncensored writing in the censorship DCF record 0x0000_55AA_ 0010_00B0
- Diary Base Address (TDM_DBA) is set at the location 0x00FC4000, (Flash Low Block2)
- Flash Low Block2 is set as OTP, writing in the DCF record 0x0004_0000_0020_0020
- Flash Low Block3 (0x00FC8000) is assigned to the Diary, writing in the DCF record TDR0_Lock0 0x0008_0000_0020_0050
- Life cycle is moved from Customer delivery to OEM production

Code, which has been tested on K2 cut 2 using Lauterbach Trace32 as debugger and Multi GHS 6.1.4 as compiler/linker, can be adapted to be used with other development tool chains.

The TDM is enabled from Customer delivery Life Cycle.

The release contains 1 GHS projects:

- "DCF_Utest_prog1.cmm"
  - Debugger script to configure the UTest Flash memory
- "K2_project_ram_vle.gpj "
  - project to test the TDM module

A.1 DCF_Utest_prog1.cmm

This script is used to configure the UTEST:

- to move the lifecycle to OEM
- to set the relevant DCFs to configure the TDM after the reset
- to configure the PASS passwords to unlock the Flash
- to set the device uncensored

Pay attention that in OEM lifecycle, the PASS protects the Flash program/erase. Known passwords shall be saved into the UTEST.

e. Content on this appendix can be also found in the file README.txt included in the reference code

A.2 K2_project_ram_vle.gpj

Following steps shall be used to execute the reference code:

1. Run the debugger script in order to configure the UTest
2. Load the executable code into RAM

Appendix B Acronyms

Table 2. Acronyms

Acronym	Name
TDM	Tamper Detection Module
DCF	Device Configuration Format Records
UTest	User Test Flash block
OTP	One Time Programming
TDR	Tamper Detection Region
DBA	Diary Base Address
SSCM	System Status and Configuration Module
TO	Tamper Override
RM	Reference Manual

Revision history

Table 3. Document revision history

Date	Revision	Changes
02-Oct-2014	1	Initial release.

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