Optical Navigation Datasheet NAV V 0.2

Resources	API Memory (Bytes)		Pins (per External I/O)
	flash	RAM	
CYONS2010, CYONS2011, CYONSFN2051, CYONSFN2053, CYONSFN2061, CYONSFN2151, CYONSFN2161, CYONSFN2162	3656	39	-

Features and Overview

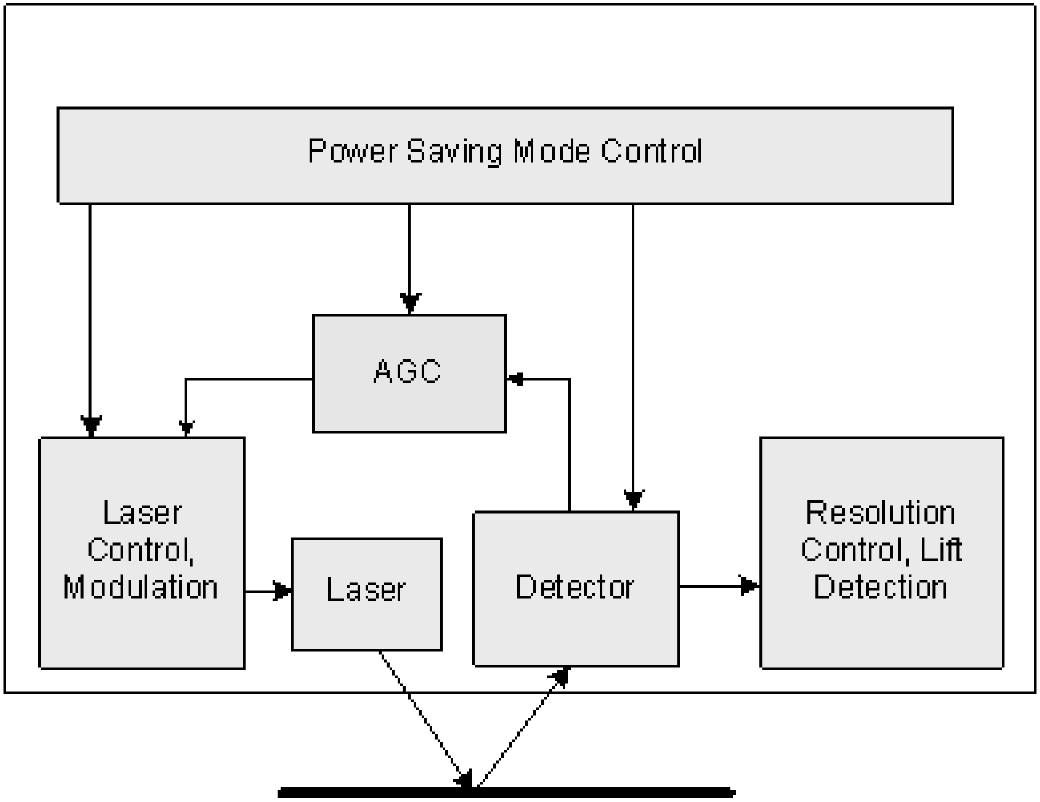
- Flexible track and sleep modes
- Configurable lift detection threshold
- Track and sleep modes can be software controlled
- Configurable resolution
- Power settings for eye safe levels of work with laser

The optical navigation system can be divided into three blocks:

- The Tracking System Control block manages surface tracking, including the resolution in the x and y directions and lift height.
- The Power Saving Mode Control block configures the various sleep and tracking modes available to the sensor. This block can force the sensor to a certain tracking or sleep mode, and also can set the parameters used by the sensor as it automatically transitions between active and sleep states.
- The Laser Control block controls the settings of the laser, allowing the user to enable/disable AGC and laser modulation, and to enter laser test mode. Laser eye safe requirements are available as a semi-automatic feature of the laser control APIs. Laser calibration is stored in protected rows of flash and can be obtained on the fly, as an API function.

Additionally the AGC block uses velocity data from the DSP block to control the sensor sampling rate. At low speeds the sensor can sample the input signals at a low rate, and hence lower speed, without sacrificing accuracy. At higher speeds the sampling rate must increase to keep up with motion. Since the sampling rate is intimately tied to the frame integration time and the DSP calculations are independent of sampling rate, it makes sense to have the AGC block control the sampling rate.

Figure 1. NAV Block Diagrams


Power Saving Mode Control
AGC
Laser Control, Modulation
Laser
Detector
Resolution Control, Lift Detection

Functional Description

The device has multiple operating modes. These are:

Active Modes

Active mode with highest speed tracking

In this mode, the chip tracks the highest speed motion of the mouse. The rate at which the device captures information from the analog chip can be up to 80KHz. The chip also consumes the highest power.

Active modes with low speed tracking

In these modes, the device modulates frame rate based on detected speed of mouse motion. This reduces active chip power.

Sleep Modes

These are low power modes to enhance battery life. If the device does not detect any motion for a programmable amount of time while in the tracking mode, it transitions to the shallowest sleep modes. The device has been provided with 4 sleep modes. If the chip has been in a sleep mode for long enough time (programmable) without detecting any motion, the chip may enter the next deeper sleep mode if there is one available

Shallowest sleep modes with low wakeup time

This mode is entered when the chip detects no mouse motion for an extended period of time. Once, this mode is entered, the device consumes only leakage power, for a major portion of time. However, the chip needs to detect if mouse movement is happening. Hence, once in a while, the device wakes up the analog super block and takes a few frame samples to check for motion. If no motion is detected, the chip re-enters sleep mode. Else, it moves into track mode.

Deep sleep modes with higher wake-up times

These modes are entered when the device detects no mouse motion for a long period of time. There are three such modes. Once a particular deep sleep mode is entered, the chip consumes only leakage power, for a major portion of time. However, the device needs to detect if mouse movement is happening. Hence, once in a while, the chip wakes up the analog superblock and takes a few frame samples to check for motion. If no motion is detected, the device re-enters the same sleep mode. Else, it moves into track mode. This mode differs from the previous mode in the duration between taking frames.

DC and AC Electrical Characteristics

See the device datasheet for your Ovation device for the electrical characteristics of the Navigation block.

Placement

The Optical Navigation User Module can be placed in the dedicated block of CYONS2xxx only.

Parameters and Resources

SleepModes

This sleep modes parameter performs basic power management configuration. Possible values are "enable" or "disable".

Application Programming Interface

The Application Programming Interface (API) functions are provided as part of the user module to allow you to deal with the module at a higher level. This section specifies the interface to each function together with related constants provided by the include files.

The following tables list the NAV supplied API functions.

Table 1. NAV API

Function	Description
General Purpose API	
void **NAV_Start**(void)	A null function, maintained for user module API consistency
void **NAV_Stop**(void)	A null function, maintained for user module API consistency.
Tracking API	
BYTE **NAV_bTrackInit** (BYTE bPowerMode)	Initializes the tracking engine with the built-in register settings.
void **NAV_TrackStart**(void)	Starts the navigation engine.

Function	Description
void **NAV_TrackStop**(void)	Stops the navigation engine.
void **NAV_SetResolution**(WORD wDPI)	Sets desired optical sensor resolution for both X and Y axes
void **NAV_SetXResolution**(WORD wXDPI)	Sets desired optical sensor resolution for both X axis
void **NAV_SetYResolution**(WORD wYDPI)	Sets desired optical sensor resolution for both Y axis
WORD **NAV_wReadResolution**(void)	Returns current resolution. In the axes resolutions are different it returns X axis resolution.
WORD **NAV_wReadXResolution**(void)	Returns current X-axis resolution.
WORD **NAV_wReadYResolution**(void)	Returns current Y-axis resolution.
BOOL **NAV_fReadXYCounts**(POSITION* SXYData)	Reads XY counts and updates the SXYData structure. Returns false if both X and Y are zero, and true otherwise
void **NAV_LiftHeightSetThreshold**(BYTE bLiftThreshold, BYTE bLiftHysteresis)	Change lift height threshold and hysteresis.
BYTE **NAV_bLiftHeightReadData**(void)	Returns the current lift height estimation in counts relative to the maximum.
Power-Saving Mode Control API	
void **NAV_ForceSleepMode**(BYTE bSleepMode)	Go to the sleep mode specified by the given index.
void **NAV_ForceTrackMode**(BYTE bTrackMode)	Go to the track mode specified by the given index.
void **NAV_ConfigureSleepMode**(BYTE bSleepMode, WORD wSleepPeriod, WORD wNumSleepPeriods)	Adjust the sleep period before next check-for-motion, and how long to stay in current sleep mode without seeing motion before moving to next deeper sleep mode (number of sleep period repeats), for the sleep mode specified by the given index (0 to 3)
void **NAV_SetSleepDelay**(WORD wDelayMs)	Adjust the delay in mS when transitioning from the lowest tracking mode to the shallowest sleep mode with no motion being detected.
void **NAV_SleepEnableInt**(void)	Enables the sleep interrupt that is generated by the navigation module.
void **NAV_SleepDisableInt**(void)	Disables the sleep interrupt that is generated by the navigation module.
void **NAV_WakeEnableInt**(void)	Enables the wake-up interrupt that is generated by the Navigation module.
void **NAV_WakeDisableInt**(void)	Disables the wake-up interrupt that is generated by the Navigation module.
void **NAV_VCSELErrorEnableInt**(void)	Enables the general interrupt that is generated by the navigation engine as a result of a VCSEL error.
void **NAV_VCSELErrorDisableInt**(void)	Disables the general interrupt that is generated by the navigation engine as a result of a VCSEL error
void **NAV_GlobalEnableInt**(void)	Enables Global interrupt

Function	Description
void **NAV_GlobalDisableInt**(void)	Disables Global interrupt
void **NAV_TrackSleepTransitionEnableInt**(void)	Enables Global subinterrupt: Track/SleepTransition
void **NAV_TrackSleepTransitionDisableInt**(void)	Disables Global subinterrupt: Track/SleepTransition
BOOL **NAV_fHadVcselError**(void)	Checks VCSEL Error status bit
BOOL **NAV_fHadTrackSleepTransition**(void)	Checks Track/Sleep Transition status bit
BOOL **NAV_fHadTrackingBlankout**(void)	Checks Track/Sleep Blackout status bit
void **NAV_ResetVcsel**(void)	Performs DSP soft reset
BYTE **NAV_bReadCurrentPreviousState**(void)	Reads previous and current track/sleep state in sensor
Laser Control API	
void **NAV_LaserStart**(void)	Turns on the laser driver
void **NAV_LaserStop**(void)	Turns off the laser drive
void **NAV_LaserSetPower**(BYTE bPowerSetting)	Manually change the laser power
void **NAV_LaserAGCControl**(BOOL fAGC)	Turn on/off the AGC loop.
void **NAV_LaserModulationControl**(BOOL fOnOff)	Turn on/off the laser modulation.
BYTE **NAV_bLaserReadPower**(void)	Returns the current laser power setting.
BYTE **NAV_bLaserReadEyesafe**(void)	Returns the laser driver eye-safe level for this sensor part.
BYTE **NAV_bLaserReadMaximum**(void)	Returns the laser driver maximum current setting for this sensor part.
void **NAV_LaserSetTestMode**(void)	Sets the laser to CW mode, without modulation and without AGC
void **NAV_LaserSetEyesafe**(BYTE bPowerSetting)	Assigns eye safety VCSEL current settings for all track modes
void **NAV_LaserSetMaximum**(BYTE bPowerSetting)	Assigns operating VCSEL current settings for all track modes
void **NAV_LaserSetEyesafeMSB**(BYTE bPowerSetting)	Sets 3 bits of DAC2 code for VCSEL driver.
void **NAV_LaserSetMaximumMSB**(BYTE bPowerSetting)	Sets 3 bits of DAC1 code for VCSEL driver.
BYTE **NAV_bLaserReadEyesafeMSB**(void)	Reads 3 bits of DAC2 code for VCSEL driver
BYTE **NAV_bLaserReadMaximumMSB**(void)	Reads 3 bits of DAC1 code for VCSEL driver
void **NAV_AnalogStart**(void)	Clears the power down bits for AGC, sensor1, sensor2, bicells and ASB
void **NAV_AnalogStop**(void)	Sets the power down bits for AGC, sensor1, sensor2, bicells and ASB

Each time a user module is placed, it is assigned an instance name. By default, PSoC Designer assigns the NAV_1 to the first instance of this user module in a given project. It can be changed to any unique value that follows the syntactic rules for identifiers. The assigned instance name becomes the prefix of every global function name, variable and constant symbol. In the following descriptions the instance name has been shortened to NAV for simplicity.

Note ** In this, as in all user module APIs, the values of the A and X register may be altered by calling an API function. It is the responsibility of the calling function to preserve the values of A and X before the call if those values are required after the call. This "registers are volatile" policy was selected for efficiency reasons and has been in force since version 1.0 of PSoC Designer. The C compiler automatically takes care of this requirement. Assembly language programmers must also ensure their code observes the policy. Though some user module API functions may leave A and X unchanged, there is no guarantee they may do so in the future.

General Purpose API

NAV_Start

Description:

A null function, maintained for user module API consistency.

C Prototype:

```
void  NAV_Start(void);
```

Assembly:

```
lcall  NAV_Start
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_Stop

Description:

A null function, maintained for user module API consistency.

C Prototype:

```
void  NAV_Stop(void);
```

Assembly:

```
lcall  NAV_Stop
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

Tracking API

NAV_bTrackInit

Description:

Initializes the tracking engine with the built-in register settings. These settings (flash table) is set by default when the user module is placed and code is generated. This guarantees proper operation after the boot sequence is completed.

C Prototype:

```
BYTE  NAV_bTrackInit(BYTE bPowerMode);
```

Assembly:

```
mov A, bPowerMode
lcall  NAV_TrackInit
;now error code contains is passed through A register
```

Parameters:

bPowerMode - chip power mode

Return Value:

Return value	Description
0	There was no error during tracking engine initialization
1	Check sum is failed
2	bPowerMode doesn’t correspond to silicon purpose

Side Effects:

See Note ** at the beginning of the API section.

NAV_TrackStart

Description:

Starts the navigation engine. The NAV_TrackInit() should be called before calling this function. This gives you the ability to modify tracking registers to your own desired values before you call NAV_TrackStart().

C Prototype:

```
void  NAV_TrackStart(void);
```

Assembly:

```
lcall  NAV_TrackStart
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_TrackStop

Description:

Stops the navigation engine. After the NAV engine is stopped, to restart the engine, call NAV_TrackInit() first, then you have the option to modify tracking registers to your own desired values, before calling NAV_TrackStart().

C Prototype:

```
void NAV_TrackStop(void);
```

Assembly:

```
lcall NAV_TrackStop
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_SetResolution

Description:

Converts the new resolution in DPI to the appropriate X-axis and Y-axis resolution scaling register values (the same value for both registers).

C Prototype:

```
void NAV_SetResolution(WORD wDPI);
```

Assembly:

```
mov   X, >wDPI
mov   A, <wDPI
lcall NAV_SetResolution
```

Parameters:

wDPI - specifies the resolution in DPI for both X and Y directions (X <= MSB; A <= LSB)

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_SetXResolution

Description:

Converts the new x-axis resolution in DPI to the appropriate X-axis resolution scaling register value.

C Prototype:

```
void NAV_SetXResolution(WORD wXDPI);
```

Assembly:

```
mov   X, >wXDPI
mov   A, <wXDPI
lcall  NAV_SetXResolution
```

Parameter:

wXDPI - specify the X-axis resolution in DPI (X <= MSB; A <= LSB)

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_SetYResolution

Description:

Converts the new y-axis resolution in DPI to the appropriate Y-axis resolution scaling register value.

C Prototype:

```
void  NAV_SetYResolution(WORD wYDPI);
```

Assembly:

```
mov   X, >wYDPI
mov   A, <wYDPI
lcall NAV_SetYResolution
```

Parameters:

wYDPI - specify the Y-axis resolution in DPI (X <= MSB; A <= LSB)

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_wReadResolution

Description:

This function converts the value in the resolution register to the equivalent DPI value and returns the X and Y axis DPI value. This function is identical to NAV_ReadXResolution. If you set the X and Y resolution with the NAV_SetResolution() API function, the X and Y axes are both set to the same resolution and this function returns the resolution. If the values are not the same, this function returns the X axis resolution.

C Prototype:

```
WORD  NAV_wReadResolution(void);
```

Assembly:

```
lcall NAV_wReadResolution
; now X contains MSB and A - LSB of returned value
```

Parameters:

None

Return Value:

Returns the current X-axis and Y-axis resolution setting in DPI. X <= MSB part of result; A <= LSB part of result

Side Effects:

See Note ** at the beginning of the API section.

NAV_wReadXResolution

Description:

Returns current X-axis resolution setting in DPI

C Prototype:

```
WORD  NAV_wReadXResolution(void);
```

Assembly:

```
lcall NAV_wReadXResolution
; now X contains MSB and A - LSB of returned value
```

Parameters:

None

Return Value:

Returns the current X-axis resolution setting in DPI. X <= MSB part of result; A <= LSB part of result.

Side Effects:

See Note ** at the beginning of the API section.

NAV_wReadYResolution

Description:

Returns current Y-axis resolution setting in DPI

C Prototype:

```
WORD  NAV_wReadYResolution(void);
```

Assembly:

```
lcall NAV_wReadYResolution
; now X contains MSB and A - LSB of returned value
```

Parameters:

None

Return Value:

Returns the current y-axis resolution setting in DPI.

X <= MSB part of result; A <= LSB part of result

Side Effects:

See Note ** at the beginning of the API section.

NAV_fReadXYCounts

Description:

Reads XY counts and updates the SXYData structure. Upon reading, the XY counts register is cleared. This function assumes the following typedef:

```
typedef struct {INT iX; INT iY;} POSITION;

and POSITION type is supported by NAV user module.
```

C Prototype:

```
BOOL NAV_fReadXYCounts(POSITION* SXYData);
```

Assembly:

```
mov X, <SXYData
mov A, >SXYData
lcall NAV_fReadXYCounts
; now A contains returned value
```

Parameters:

Pointer MSB => A, LSB => X that contains tracking data after function returns

Return Value:

A <= Returns true if non-zero xy_data was read, false if xy data is zero

Side Effects:

See Note ** at the beginning of the API section.

The XY registers of optical navigation system is cleared after this function call. Function modificates value of structure that SXYData points on.

NAV_LiftHeightSetThreshold

Description:

Changes lift height threshold and hysteresis

C Prototype:

```
void NAV_LiftHeightSetThreshold(BYTE bLiftThreshold, BYTE bLiftHysteresis);
```

Assembly:

```
mov X, bLiftHysteresis
mov A, bLiftThreshold
lcall NAV_LiftHeightSetThreshold
```

Parameters:

A <= bLiftThreshold (Lift height threshold in relative units where the tracking is cut off. Allowable range is 0 - 7).

X <= bLiftHysteresis (Lift height hysteresis in relative units to stabilize lift detection. bLiftHysteresis uses the same units and can range from 0 (no hysteresis) to bLiftThreshold).

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_bLiftHeightReadData

Description:

Returns the current lift height estimation in counts relative to the maximum. Range is 0 - 7 counts.

C Prototype:

```
BYTE NAV_bLiftHeightReadData(void);
```

Assembly:

```
lcall NAV_bLiftHeightReadData
; now A contains returned value
```

Parameters:

None

Return Value:

A <= current lift height estimation

Side Effects:

See Note ** at the beginning of the API section.

Power-Saving Mode Control API

NAV_ForceSleepMode

Description:

Goes to the sleep mode specified by the given index from 0 to 3 immediately. This function may be called after you call the NAV_TrackStart() function. Sleep mode with higher index uses longer sleep period, that is, implements deeper sleep and saves more power.

C Prototype:

```
void NAV_ForceSleepMode(BYTE bSleepMode);
```

Assembly:

```
mov     A, bSleepMode
lcall    NAV_ForceSleepMode
```

Parameters:

bSleepMode - specifies index of the sleep mode to go to immediately. Passed via accumulator.

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_ForceTrackMode

Description:

Jumps to the tracking mode specified by the given index from 0 to 5 immediately. This function may be called only after the NAV_TrackStart() function. Tracking mode with higher index uses higher sampling rate.

C Prototype:

```
void NAV_ForceTrackMode(BYTE bTrackMode);
```

Assembly:

```
mov     A, bTrackMode
lcall    NAV_ForceTrackMode
```

Parameters:

bTrackMode - specifies index of the tracking mode to jump to immediately. Passed via accumulator.

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_ConfigureSleepMode

Description:

Sets the sleep period (before next check-for-motion), sleep mode duration (without seeing motion before moving to next deeper sleep mode) and number of sleep period repeats for the sleep mode specified by the given index (0 to 3). This function should be called after NAV_TrackInit() function (initializes tracking engine) and before calling the NAV_TrackStart() function (starting tracking engine). Please note that sleep mode with higher index should use longer sleep period, that is, implements deeper sleep and saves more power. Sleep mode 0 is the shallowest sleep mode; sleep mode 3 is the deepest sleep mode.

C Prototype:

```
void  NAV_ConfigureSleepMode(BYTE bSleepMode, WORD wSleepPeriod, WORD
wNumSleepPeriods);
```

Assembly:

```
mov   A, >wNumSleepPeriods       ;MSB of last argument
push  A
mov   A, <wNumSleepPeriods       ;LSB
push  A
mov   A, >wSleepPeriod           ;MSB
push  A
mov   A, <wSleepPeriod           ;LSB
```

```
push   A
mov    A,  bSleepMode              ;first argument
push   A
lcall   NAV_ConfigureSleepMode
add    SP, -5                      ;stack release
```

Parameters:

bSleepMode - specifies the index of the sleep mode to adjust.

wSleepPeriod - sleep period in ms before next check-for-motion activity.

wNumSleepPeriods - number of sleep period repeats before transitioning to next deeper sleep mode

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_SetSleepDelay

Description:

Adjusts the delay in ms when transitioning from the lowest tracking mode (track mode 0) to the shallowest sleep mode (sleep mode 0) with no motion being detected. This function must be called after NAV_Trackinit() and before calling the NAV_TrackStart() function (starting tracking engine).

C Prototype:

```
void  NAV_SetSleepDelay(WORD wDelayMs);
```

Assembly:

```
mov X, >wDelayMs
mov A, <wDelayMs
lcall NAV_wDelayMs
```

Parameters:

wDelayMs - delay in ms before transitioning from tracking mode to sleep mode when no motion is detected (X <= MSB; A <= LSB)

Return Value:

None.

Side Effects:

See Note ** at the beginning of the API section.

NAV_SleepEnableInt

Description:

Enables the sleep interrupt that is generated by the Navigation module. In typical usage this interrupt is used by the NAV user module to tell the CPU core to go to sleep

C Prototype:

```
void  NAV_SleepEnableInt(void);
```

Assembly:

```
lcall  NAV_SleepEnableInt
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_SleepDisableInt

Description:

Disables the sleep interrupt that is generated by the Navigation module.

C Prototype:

```
void  NAV_SleepDisableInt(void);
```

Assembly:

```
lcall  NAV_SleepDisableInt
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_WakeEnableInt

Description:

Enables the wake-up interrupt that is generated by the Navigation module. In typical usage this interrupt is used by the Nav module to tell the Krypton controller to wake from sleep, which may occur if the mouse is configured to support wake-on-motion from a USB suspend.

C Prototype:

```
void  NAV_WakeEnableInt(void);
```

Assembly:

```
lcall  NAV_WakeEnableInt
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_WakeDisableInt

Description:

Disables the wake-up interrupt that is generated by the Navigation module.

C Prototype:

```
void  NAV_WakeDisableInt(void);
```

Assembly:

```
lcall  NAV_WakeDisableInt
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_GlobalEnableInt

Description:

Enables global interrupt.

C Prototype:

```
void  NAV_GlobalEnableInt(void);
```

Assembly:

```
lcall  NAV_GlobalEnableInt
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_GlobalDisableInt

Description:

Disables Global interrupt.

C Prototype:

```
void  NAV_GlobalDisableInt(void);
```

Assembly:

```
lcall  NAV_GlobalDisableInt
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_TrackSleepTransitionEnableInt

Description:

Enables Track/SleepTransition interrupt.

C Prototype:

```
void  NAV_TrackSleepTransitionEnableInt(void);
```

Assembly:

```
lcall  NAV_TrackSleepTransitionEnableInt
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_TrackSleepTransitionDisableInt

Description:

Disables Track/SleepTransition interrupt..

C Prototype:

```
void  NAV_TrackSleepTransitionDisableInt(void);
```

Assembly:

```
lcall  NAV_TrackSleepTransitionDisableInt
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_fHadVcselError

Description:

Checks VCSEL Error status bit. Clears if set.

C Prototype:

```
BOOL  NAV_fHadVcselError(void);
```

Assembly:

```
lcall  NAV_fHadVcselError
```

Parameters:

None

Return Value:

Returns (through A register) VCSEL Error status bit

Side Effects:

See Note ** at the beginning of the API section.

NAV_fHadTrackSleepTransition

Description:

Checks Track/Sleep Transition status bit. Clears if set.

C Prototype:

```
BOOL  NAV_fHadTrackSleepTransition(void);
```

Assembly:

```
lcall  NAV_fHadTrackSleepTransition
```

Parameters:

None

Return Value:

Returns (through A register) Track/Sleep Transition status bit

Side Effects:

See Note ** at the beginning of the API section.

NAV_fHadTrackingBlankout

Description:

Checks Blankout status bit. Interrupt occurs when signal is too low and tracking output is blanked out.

C Prototype:

```
BOOL  NAV_fHadTrackingBlankout(void);
```

Assembly:

```
lcall  NAV_fHadTrackingBlankout
```

Parameters:

None

Return Value:

Returns (through A register) Blankout status bit

Side Effects:

See Note ** at the beginning of the API section.

NAV_ResetVcsel

Description:

Performs ASB and DSP soft reset.

C Prototype:

```
void  NAV_ResetVcsel(void);
```

Assembly:

```
lcall  NAV_ResetVcsel
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_bReadCurrentPreviousState

Description:

Reads current and previous track/sleep state in sensor.

C Prototype:

```
BYTE  NAV_bReadCurrentPreviousState(void);
```

Assembly:

```
lcall  NAV_bReadCurrentPreviousState
```

Parameters:

None

Return Value:

Returns (through A register) current (7:4 bits) and previous (3:0 bits) track/sleep states.

Side Effects:

See Note ** at the beginning of the API section.

Laser Control API

NAV_LaserStart

Description:

Turns on the laser driver. If AGC is off, or if CW mode is on, then the initial power resulting from this command is zero. The firmware must then set the laser power using the NAV_LaserSetPower() call.

C Prototype:

```
void  NAV_LaserStart(void);
```

Assembly:

```
lcall  NAV_LaserStart
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_LaserStop

Description:

Turns off the laser driver.

C Prototype:

```
void  NAV_LaserStop(void);
```

Assembly:

```
lcall  NAV_LaserStop
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_VCSELErrorEnableInt

Description:

Enables the general interrupt that is generated by the navigation engine as a result of a VCSEL error. Note that the general interrupt can also be generated by the power system. It is the firmware's responsibility to manage the different scenarios that are covered by this interrupt.

C Prototype:

```
void  NAV_VCSELErrorEnableInt(void);
```

Assembly:

```
lcall  NAV_VCSELErrorEnableInt
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_VCSELErrorDisableInt

Description:

Disables the VCSEL error interrupt that is generated by the Navigation module.

C Prototype:

```
void  NAV_VCSELErrorDisableInt(void);
```

Assembly:

```
lcall  NAV_VCSELErrorDisableInt
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_LaserSetPower

Description:

Manually changes the driver current setting. Should only be used when AGC loop is turned off, otherwise there is no effect.

C Prototype:

```
void  NAV_LaserSetPower(BYTE bPowerSetting);
```

Assembly:

```
mov   A, bPowerSetting
lcall  NAV_LaserSetPower
```

Parameters:

bPowerSetting - laser driver current setting

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_LaserAGCControl

Description:

Turn on/off the AGC loop.

C Prototype:

```
void  NAV_LaserAGCControl(BOOL fAGC);
```

Assembly:

```
mov   A, fAGC
lcall  NAV_LaserAGCControl
```

Parameters:

fAGC - if non-zero value AGC loop on, otherwise AGC loop off

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_LaserModulationControl

Description:

Turn on or off the laser modulation.

C Prototype:

```
void  NAV_LaserModulationControl(BOOL fOnOff);
```

Assembly:

```
mov   A, fOnOff
lcall  NAV_LaserModulationControl
```

Parameters:

fOnOff - if non-zero value then it takes pulsed mode, otherwise CW mode

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_bLaserReadPower

Description:

Returns the current laser power setting.

C Prototype:

```
BYTE  NAV_bLaserReadPower(void);
```

Assembly:

```
lcall  NAV_bLaserReadPower
; now returned value is in A register
```

Parameters:

None

Return Value:

A <= current laser driver setting

Side Effects:

See Note ** at the beginning of the API section.

NAV_bLaserReadEyesafe

Description:

Returns the laser driver eye-safe level for this sensor part.

C Prototype:

```
BYTE  NAV_bLaserReadEyesafe(void);
```

Assembly:

```
lcall  NAV_bLaserReadEyesafe
; now returned value is in A register
```

Parameters:

None

Return Value:

A <= laser driver eye_safe level for this sensor part.

Side Effects:

See Note ** at the beginning of the API section.

NAV_bLaserReadMaximum

Description:

Returns the laser driver maximum current setting for this sensor part.

C Prototype:

```
BYTE  NAV_bLaserReadMaximum(void);
```

Assembly:

```
lcall  NAV_bLaserReadMaximum
; now returned value is in A register
```

Parameters:

None

Return Value:

A <= laser driver maximum current setting for this sensor part

Side Effects:

See Note ** at the beginning of the API section.

NAV_LaserSetTestMode

Description:

This command sets the laser to CW mode, without modulation and without AGC. These settings are needed by customers to test the laser output power for eye safety. To exit this mode, the user needs to call NAV_LaserStart.

C Prototype:

```
void  NAV_LaserSetTestMode(void);
```

Assembly:

```
lcall  NAV_LaserSetTestMode
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_LaserSetEyesafe

Description:

Sets eye safety VCSEL current value.

C Prototype:

```
void  NAV_LaserSetEyesafe(BYTE bEyeSafeCurrent);
```

Assembly:

```
mov A, bEyeSafeCurrent
lcall  NAV_LaserSetEyesafe
```

Parameters:

bEyeSafeCurrent - eye safety VCSEL current settings

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_LaserSetMaximum

Description:

Sets operating VCSEL current value.

C Prototype:

```
void  NAV_LaserSetMaximum(BYTE bOperatingCurrent);
```

Assembly:

```
mov A, bOperatingCurrent
lcall  NAV_LaserSetMaximum
```

Parameters:

bOperatingCurrent - eye safety VCSEL current settings

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_LaserSetEyesafeMSB

Description:

Sets 3 bits of DAC2 code for VCSEL driver (this is used as MSB 3 bits for the eye safety current provided to VCSEL driver).

C Prototype:

```
void  NAV_LaserSetEyesafeMSB(BYTE bEyesafeCurrCode);
```

Assembly:

```
mov A, bEyesafeCurrCode
lcall  NAV_LaserSetEyesafeMSB
```

Parameters:

bEyesafeCurrCode - eye safety current code (000b - highest current; 111b - lowest current)

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_LaserSetMaximumMSB

Description:

Sets 3 bits of DAC1 code for VCSEL driver (this is used as MSB 3 bits for the oerating current provided to VCSEL driver).

C Prototype:

```
void  NAV_LaserSetMaximumMSB(BYTE bOperatingCurrCode);
```

Assembly:

```
mov A, bOperatingCurrCode
lcall  NAV_LaserSetMaximumMSB
```

Parameters:

bOperatingCurrCode - operating current code (000b - highest current; 111b - lowest current)

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_bLaserReadEyesafeMSB

Description:

Reads 3 bits of DAC2 code for VCSEL driver.

C Prototype:

```
BYTE  NAV_bLaserReadEyesafeMSB(void);
```

Assembly:

```
lcall  NAV_bLaserReadEyesafeMSB
```

Parameters:

None

Return Value:

Returns (through A register) DAC2 code for VCSEL eyesafe current (000b - highest current; 111b - lowest current)

Side Effects:

See Note ** at the beginning of the API section.

NAV_bLaserReadMaximumMSB

Description:

Reads 3 bits of DAC1 code for VCSEL driver.

C Prototype:

```
BYTE  NAV_bLaserReadMaximum(void);
```

Assembly:

```
lcall  NAV_bLaserReadMaximum
```

Parameters:

None

Return Value:

Returns (through A register) DAC1 code for VCSEL operating current (000b - highest current; 111b - lowest current)

Side Effects:

See Note ** at the beginning of the API section.

NAV_AnalogStart

Description:

Clears the power down bits for AGC, sensor1, sensor2, bicells and ASB.

C Prototype:

```
void  NAV_AnalogStart(void);
```

Assembly:

```
lcall  NAV_AnalogStart
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

NAV_AnalogStop

Description:

Sets the power down bits for AGC, sensor1, sensor2, bicells and ASB.

C Prototype:

```
void  NAV_AnalogStop(void);
```

Assembly:

```
lcall  NAV_AnalogStop
```

Parameters:

None

Return Value:

None

Side Effects:

See Note ** at the beginning of the API section.

Sample Firmware Source Code

The C code illustrated here shows you how to use the NAV User Module.

```
#define endless_loop 1
#define WIRED 0

// Including the user module header file for POSITION definition.

#include "NAV.h"

void main(void)
{

//
// Integers to hold our X an Y counts read from the sensor.
//

int iX, iY;
//
// POSITION is defined in NAV.h.
//
// typedef struct {
// INT x;
// INT y;
// } POSITION;
//

POSITION XYData;

//
// Start the OvationONS II DSP Tracking Mode.
//
// Always call these first three NAV user modules in order.
//
// 1. NAV_TrackInit()
// 2. NAV_LaserStart()
// 3. NAV_TrackStart()
//

NAV_bTrackInit(WIRED);
NAV_LaserStart();
NAV_TrackStart();

do
{
//
// Read the change in X and Y counts from the last read.
//

NAV_fReadXYCounts(&XYData);

//
// pXYData now points to X and Y movment counts from the navigation sensor.
// Send XYData.x and XYData.y to USB, SPI, or other reporting protocol.
//

iX = XYData.x;
iY = XYData.y;

} while (endless_loop);

}
```

The Assembly code illustrated here implements a similar function to the C example.

```
;--------------------------------------------------------------------
; Assembly main line
;--------------------------------------------------------------------

include "m8c.inc"       ; part specific constants and macros
include "memory.inc"    ; Constants & macros for SMM/LMM and Compiler
include "PSoCAPI.inc"   ; PSoC API definitions for all User Modules
```

```
area bss
export _NavInfo
export  NavInfo
_NavInfo:
NavInfo: blk 4

area text
export nav_demo_init
export _nav_demo_init
export nav_demo
export _nav_demo

export _main

_main:

    ; Insert your main assembly code here.
    lcall nav_demo_init
.loop:
    lcall nav_demo
jmp .loop
.terminate:
    jmp .terminate


nav_demo_init:
_nav_demo_init:


mov A, NAV_1_WIRED
lcall NAV_1_bTrackInit

lcall NAV_1_LaserStart
lcall NAV_1_TrackStart

ret

 nav_demo:
_nav_demo:
mov X,  <NavInfo
mov A, >NavInfo
lcall NAV_1_fReadXYCounts
; data will be located in NavInfo location
ret
```

Configuration Registers

The following registers are configured in this UM. Symbolic names for these registers are defined in the user module instance C and assembly language interface files (the *.h* and *.inc* files).

Table 2.   SMx_NO_BLKS4TRANS0, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	smx_no_blks4trans (LSB)							

smx_no_blks4trans - total number of blocks before transitioning to deeper sleep mode (LSB)

Table 3. SMx_NO_BLKS4TRANS1, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	smx_no_blks4trans (MSB)							

smx_no_blks4trans - total number of blocks before transitioning to deeper sleep mode (MSB)

Table 4. SMx_CHK_INTRVL0, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	smx_chk_intrvl (LSB)							

smx_chk_intrvl - inactive interval in multiples of 4 ms between two CFM slots (LSB)

Table 5. SMx_CHK_INTRVL1, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	smx_chk_intrvl (MSB)							

smx_chk_intrvl - inactive interval in multiples of 4 ms between two CFM slots (MSB)

Table 6. TR0_S0_DOWN_SWITCH_DELAY0, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	tr0_s0_down_switch_delay (LSB)							

tr0_s0_down_switch_delay - number of blocks in TR0 before master controller enters sleep (LSB)

Table 7. TR0_S0_DOWN_SWITCH_DELAY1, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	tr0_s0_down_switch_delay (MSB)							

tr0_s0_down_switch_delay - number of blocks in TR0 before master controller enters sleep (MSB)

Table 8. NUM_BLOCKS_IN_BLANKING0, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	num_blocks_in_blanking (LSB)							

num_blocks_in_blanking - number of contiguous blocks for which blanking is detected before it jumps to sleep mode 0 (LSB)

Table 9. NUM_BLOCKS_IN_BLANKING1, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	num_blocks_in_blanking (MSB)							

num_blocks_in_blanking - number of contiguous blocks for which blanking is detected before it jumps to sleep mode 0 (MSB)

Table 10. X_CNT_REG_BUF0, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	x_cnt_reg_buf (LSB)							

x_cnt_reg_buf - X count buffer register (LSB)

Table 11. X_CNT_REG_BUF1, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	x_cnt_reg_buf (MSB)							

x_cnt_reg_buf - X count buffer register (MSB)

Table 12. Y_CNT_REG_BUF0, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	y_cnt_reg_buf (LSB)							

y_cnt_reg_buf - X count buffer register (LSB)

Table 13. Y_CNT_REG_BUF1, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	y_cnt_reg_buf (MSB)							

y_cnt_reg_buf - X count buffer register (MSB)

Table 14. RES_SCAL_DX0, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	res_scal_dx (LSB)							

res_scal_dx - used to convert Counts to DX. These can be updated on the fly. These registers can be updated, at any time, but their visibility into the algorithm is synchronized to the next block boundary

Table 15. RES_SCAL_DX1, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	res_scal_dx (MSB)							

res_scal_dx - used to convert Counts to DX. These can be updated on the fly. These registers can be updated, at any time, but their visibility into the algorithm is synchronized to the next block boundary

Table 16. RES_SCAL_DY0, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	res_scal_dy (LSB)							

res_scal_dy - used to convert Counts to DY. These can be updated on the fly. These registers can be updated, at any time, but their visibility into the algorithm is synchronized to the next block boundary

Table 17. RES_SCAL_DY1, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	res_scal_dy (MSB)							

res_scal_dy - used to convert Counts to DY. These can be updated on the fly. These registers can be updated, at any time, but their visibility into the algorithm is synchronized to the next block boundary

Table 18. DISABLE_TRACK_SLEEP, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	Reserved			mode _in_sleep			dis_slsw	dis_tksw

mode_in_sleep - This register is in sync with the T1/T2 programmed values in CFM. The user needs to ensure that "track mode" selected by this 3-bit register (for choosing the appropriate Track mode integration time registers in CFM) are compatible wth the programmed frame rate in CFM. The reg mux uses this 3 -bit register to select the integration times ONLY when sleep-mode indication is 1.

dis_slsw - disables all sleep mode switching. Only track force can be used to switch states if this bit is 1

dis_tksw - disables all types of track mode switching. Only track force can be used to enforce switching if this bit is 1

Table 19. FORCE_STATE_CTRL, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	Reserved			force_state				force_en

force_state - if [0] =1, at the current block boundary, switch to this track mode

force_en - if 1, force state machine to this state. After switch, master controller resets this bit

Table 20. PWR_DSP_CTRL_REG, Bank 1

Bit	7	6	5	4	3	2	1	0
Value	res_cpi_limit_reg				lvd_trim		tripper_calib	

res_cpi_limit_reg - resolution/CPI limiter data

lvd_trim - LVD trimming register

tripper_calib - 3V Tripper Calibration Value

Table 21. THRESHOLD1, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	threshold1							

threshold1 - is the higher threshold used in lift detection logic.

Table 22. THRESHOLD2, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	threshold2							

threshold2 - is the lower threshold used in lift detection logic.

Table 23. INTR_MASK_REG, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	Reserved				StForce	BstUVInit	TripFilOut	vcselErr

StForce - Track/sleep transition interrupt mask (whenever this interrupt is set, it means that there is a change in the track modes. It is set when track to track or sleep to sleep or sleep to track or track to sleep state transition happens).

BstUVInit - Boost UV Init interrupt mask (a low to high or high to low transition is detected as an interrupt).

TripFilOut - Tripper out filter mask (whenever power supply switching happens from wireless to wired, this signal toggles from 0 to 1. Whenever power supply switching happens from wired to wireless, this signal toggles from 1 to 0. During both the transitions, interrupt is set).

vcselErr - VCSEL Error mask (whenever this interrupt is set, it means that VCSEL is ON for more than the desired time interval. This signal makes a transition from 0 to 1 to indicate error).

Table 24. INT_MSK3, Bank 0

Bit	7	6	5	4	3	2	1	0
Value	Reserved						glb_ons	wkp_ons

glb_ons - mask optical navigation system global interrupt

wkp_ons - mask optical navigation system wakeup interrupt

Table 25. EYE_CW_VCSEL_CUR0, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	eye_cw_vcsel_cur							

eye_cw_vcsel_cur0 - continuous wave eyesafety VCSEL

Table 26. VCSEL_DAC_CURRENT_AGC, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	vcsel_dac_current_agc							

vcsel_dac_current_agc - This is the VCSEL Current provided to the VCSEL power controller block. This is updated at every block boundry. This is writeable by both CPU and the internal logic. CPU is given the highest priority

Table 27. GLOBAL_CONFIG_REG0, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	Reserved							dsp_start

dsp_start - starts tracking engine

Table 28. GLOBAL_CONFIG_REG0, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	DeviceID		Reserved					

DeviceID - choices wired/wireless device configuration

Table 29. BG_BUFF_LVD_TRIM, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	Reserved					LVD_offset_lv_trim		

LVD_offset_lv_trim - LVD trimming setting

Table 30. TMx_EYE_SAFE_CURR0, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	tmx_eyesaf_curr							

tmx_eyesaf_curr - Eye safety current for corresponding track mode

Table 31. TMx_MAX_VCSEL_PWR0, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	tmx_max_vcsel_pwr							

tmx_max_vcsel_pwr - max integration time. This is selected based on the track mode.

Table 32. MAX_CW_VCSEL_CUR0, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	max_cw_vcsel_cur							

max_cw_vcsel_cur0 - continuous wave Max VCSEL

Table 33. AVERAGED_AGC_TAR_MIN0, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	averaged_agc_tar_min (LSB)							

averaged_agc_tar_min - averaged AGC target min for the computation of Gain for AGC and differential channels; integration time and VCSEL current.

Table 34. AVERAGED_AGC_TAR_MIN1, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	Reserved							averaged_agc_tar_min (MSB)

averaged_agc_tar_min - averaged AGC target minimum for the computation of Gain for AGC and differential channels; integration time and VCSEL current.

Table 35. AVERAGED_AGC_TAR_MAX0, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	averaged_agc_tar_max (LSB)							

averaged_agc_tar_max - averaged AGC target maximum for the computation of Gain for AGC and differential channels; integration time and VCSEL current.

Table 36. AVERAGED_AGC_TAR_MAX1, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	Reserved							averaged_agc_tar_max (MSB)

averaged_agc_tar_max - averaged AGC target maximum for the computation of Gain for AGC and differential channels; integration time and VCSEL current.

Table 37. PEER_PRESSURE_PIPELINE_DEPTH, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	Reserved				peer_pressure_pipeline_depth			

peer_pressure_pipeline_depth - peer pressure depth to be used. If this is programmed to 0, peer pressure is disabled.

Table 38. TMx_BLNK_HYST, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	tmx_blnk_hyst							

tmx_blnk_hyst - blanking hysteresis value for each tracking mode

Table 39. TMx_BLNK_THRES, Bank 2

Bit	7	6	5	4	3	2	1	0
Value	tmx_blnk_thres							

tmx_blnk_thres - blanking threshold value for each tracking mode (blank out signal if dpp < Blank Thrsh)

Table 40. SMx_BLANKING_THRESHOLD_REG, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	smx_blanking_threshold_reg							

smx_blanking_threshold_reg - blanking threshold to be used in corresponding sleep mode CFM. Can be written on the fly.

Table 41. ADC_CTRL_REG, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	Reserved	sel_hi_bw	vbias_en	winshift_hw			winalt_hv	

sel_hi_bw - When high, makes the bandwidth of diff. TIA from 40kHz to 150kHz

vbias_en - When high, enables the path for vbias to ADC. When low, enable the path for vbias to CDS test input

winshift_hv - This register is for shifting the full ADC conversion window

winalt_hv - This register is for for altering the range of the ADC conversion window

Table 42. CURRENT_VCSEL_OPPT_REG0, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	current_vcsel_oppt_reg							

current_vcsel_oppt_reg - Current VCSEL operating current value. These registers are generated based on the VCSEL_ON signal from the analog block

Table 43. CURRENT_VCSEL_EYESAF_REG0, Bank 3

Bit	7	6	5	4	3	2	1	0
Value	current_vcsel_eyesaf_reg							

current_vcsel_eyesaf_reg - current VCSEL eye safety current value. These registers are genera-ted based on the VCSEL_ON signal from the analog block

Version History

Version	Originator	Description
0.2	DHA	Added Version History

Note PSoC Designer 5.1 introduces a Version History in all user module datasheets. This section documents high level descriptions of the differences between the current and previous user module versions.

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