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WAN PLL

IDT82V3285A

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Table of Contents

FEATURES	9
HIGHLIGHTS.....	9
MAIN FEATURES	9
OTHER FEATURES.....	9
APPLICATIONS	9
DESCRIPTION	10
FUNCTIONAL BLOCK DIAGRAM	11
1 PIN ASSIGNMENT	12
2 PIN DESCRIPTION	13
3 FUNCTIONAL DESCRIPTION	18
3.1 RESET	18
3.2 MASTER CLOCK	18
3.3 INPUT CLOCKS & FRAME SYNC SIGNAL	19
3.3.1 Input Clocks	19
3.3.2 Frame SYNC Input Signals	19
3.4 INPUT CLOCK PRE-DIVIDER	20
3.5 INPUT CLOCK QUALITY MONITORING	21
3.5.1 Activity Monitoring	21
3.5.2 Frequency Monitoring	22
3.6 T0 / T4 DPLL INPUT CLOCK SELECTION	23
3.6.1 External Fast Selection (T0 only)	23
3.6.2 Forced Selection	24
3.6.3 Automatic Selection	24
3.7 SELECTED INPUT CLOCK MONITORING	25
3.7.1 T0 / T4 DPLL Locking Detection	25
3.7.1.1 Fast Loss	25
3.7.1.2 Coarse Phase Loss	25
3.7.1.3 Fine Phase Loss	25
3.7.1.4 Hard Limit Exceeding	25
3.7.2 Locking Status	25
3.7.3 Phase Lock Alarm (T0 only)	26
3.8 SELECTED INPUT CLOCK SWITCH	27
3.8.1 Input Clock Validity	27
3.8.2 Selected Input Clock Switch	27
3.8.2.1 Revertive Switch	27
3.8.2.2 Non-Revertive Switch (T0 only)	28
3.8.3 Selected / Qualified Input Clocks Indication	28
3.9 SELECTED INPUT CLOCK STATUS VS. DPLL OPERATING MODE	29
3.9.1 T0 Selected Input Clock vs. DPLL Operating Mode	29
3.9.2 T4 Selected Input Clock vs. DPLL Operating Mode	31
3.10 T0 / T4 DPLL OPERATING MODE	32
3.10.1 T0 DPLL Operating Mode	32
3.10.1.1 Free-Run Mode	32
3.10.1.2 Pre-Locked Mode	32
3.10.1.3 Locked Mode	32
3.10.1.3.1 Temp-Holdover Mode	32

3.10.1.4	Lost-Phase Mode	32
3.10.1.5	Holdover Mode	32
3.10.1.5.1	Automatic Instantaneous	33
3.10.1.5.2	Automatic Slow Averaged	33
3.10.1.5.3	Automatic Fast Averaged	33
3.10.1.5.4	Manual	33
3.10.1.5.5	Holdover Frequency Offset Read	33
3.10.1.6	Pre-Locked2 Mode	33
3.10.2	T4 DPLL Operating Mode	33
3.10.2.1	Free-Run Mode	33
3.10.2.2	Locked Mode	33
3.10.2.3	Holdover Mode	33
3.11	T0 / T4 DPLL OUTPUT	35
3.11.1	PFD Output Limit	35
3.11.2	Frequency Offset Limit	35
3.11.3	PBO (T0 only)	35
3.11.4	Phase Offset Selection (T0 only)	35
3.11.5	Four Paths of T0 / T4 DPLL Outputs	35
3.11.5.1	T0 Path	35
3.11.5.2	T4 Path	36
3.12	T0 / T4 APLL	37
3.13	OUTPUT CLOCKS & FRAME SYNC SIGNALS	37
3.13.1	Output Clocks	37
3.13.2	Frame SYNC Output Signals	39
3.14	MASTER / SLAVE CONFIGURATION	42
3.15	INTERRUPT SUMMARY	43
3.16	T0 AND T4 SUMMARY	43
3.17	POWER SUPPLY FILTERING TECHNIQUES	44
4	TYPICAL APPLICATION	45
4.1	MASTER / SLAVE APPLICATION	45
5	MICROPROCESSOR INTERFACE	46
5.1	EPROM MODE	47
5.2	MULTIPLEXED MODE	48
5.3	INTEL MODE	50
5.4	MOTOROLA MODE	52
5.5	SERIAL MODE	54
6	JTAG	56
7	PROGRAMMING INFORMATION	57
7.1	REGISTER MAP	57
7.2	REGISTER DESCRIPTION	62
7.2.1	Global Control Registers	62
7.2.2	Interrupt Registers	71
7.2.3	Input Clock Frequency & Priority Configuration Registers	75
7.2.4	Input Clock Quality Monitoring Configuration & Status Registers	86
7.2.5	T0 / T4 DPLL Input Clock Selection Registers	97
7.2.6	T0 / T4 DPLL State Machine Control Registers	102
7.2.7	T0 / T4 DPLL & APLL Configuration Registers	104
7.2.8	Output Configuration Registers	118
7.2.9	PBO & Phase Offset Control Registers	125
7.2.10	Synchronization Configuration Registers	127
8	THERMAL MANAGEMENT	128
8.1	JUNCTION TEMPERATURE	128
8.2	EXAMPLE OF JUNCTION TEMPERATURE CALCULATION	128

8.3	HEATSINK EVALUATION	128
8.4	TQFP EPAD THERMAL RELEASE PATH	129
9	ELECTRICAL SPECIFICATIONS	130
9.1	ABSOLUTE MAXIMUM RATING	130
9.2	RECOMMENDED OPERATION CONDITIONS	130
9.3	I/O SPECIFICATIONS	131
9.3.1	CMOS Input / Output Port	131
9.3.2	PECL / LVDS Input / Output Port	132
9.3.2.1	PECL Input / Output Port	132
9.3.2.2	LVDS Input / Output Port	134
9.3.2.3	Single-Ended Input for Differential Input	135
9.4	JITTER & WANDER PERFORMANCE	136
9.5	OUTPUT WANDER GENERATION	139
9.6	INPUT / OUTPUT CLOCK TIMING	140
9.7	OUTPUT CLOCK TIMING	141
	PACKAGE DIMENSIONS.....	146
	ORDERING INFORMATION.....	149



List of Tables

Table 1: Pin Description	13
Table 2: Related Bit / Register in Chapter 3.2	18
Table 3: Related Bit / Register in Chapter 3.3	19
Table 4: Related Bit / Register in Chapter 3.4	20
Table 5: Related Bit / Register in Chapter 3.5	22
Table 6: Input Clock Selection for T0 Path	23
Table 7: Input Clock Selection for T4 Path	23
Table 8: External Fast Selection	23
Table 9: Related Bit / Register in Chapter 3.6	24
Table 10: Coarse Phase Limit Programming (the selected input clock of 2 kHz, 4 kHz or 8 kHz)	25
Table 11: Coarse Phase Limit Programming (the selected input clock of other than 2 kHz, 4 kHz and 8 kHz)	25
Table 12: Related Bit / Register in Chapter 3.7	26
Table 13: Conditions of Qualified Input Clocks Available for T0 & T4 Selection	27
Table 14: Related Bit / Register in Chapter 3.8	28
Table 15: T0 DPLL Operating Mode Control	29
Table 16: T4 DPLL Operating Mode Control	31
Table 17: Related Bit / Register in Chapter 3.9	31
Table 18: Frequency Offset Control in Temp-Holdover Mode	32
Table 19: Frequency Offset Control in Holdover Mode	33
Table 20: Holdover Frequency Offset Read	33
Table 21: Related Bit / Register in Chapter 3.10	34
Table 22: Related Bit / Register in Chapter 3.11	36
Table 23: Related Bit / Register in Chapter 3.12	37
Table 24: Outputs on OUT1 ~ OUT5 if Derived from T0/T4 DPLL Outputs	37
Table 25: Outputs on OUT1 ~ OUT5 if Derived from T0/T4 APLL	38
Table 26: Synchronization Control	39
Table 27: Related Bit / Register in Chapter 3.13	41
Table 28: Device Master / Slave Control	42
Table 29: Related Bit / Register in Chapter 3.15	43
Table 30: Microprocessor Interface	46
Table 31: Access Timing Characteristics in EPROM Mode	47
Table 32: Read Timing Characteristics in Multiplexed Mode	48
Table 33: Write Timing Characteristics in Multiplexed Mode	49
Table 34: Read Timing Characteristics in Intel Mode	50
Table 35: Write Timing Characteristics in Intel Mode	51
Table 36: Read Timing Characteristics in Motorola Mode	52
Table 37: Write Timing Characteristics in Motorola Mode	53
Table 38: Read Timing Characteristics in Serial Mode	54
Table 39: Write Timing Characteristics in Serial Mode	55
Table 40: JTAG Timing Characteristics	56
Table 41: Register List and Map	57
Table 42: Power Consumption and Maximum Junction Temperature	128
Table 43: Thermal Data	128
Table 44: Absolute Maximum Rating	130
Table 45: Recommended Operation Conditions	130
Table 46: CMOS Input Port Electrical Characteristics	131
Table 47: CMOS Input Port with Internal Pull-Up Resistor Electrical Characteristics	131
Table 48: CMOS Input Port with Internal Pull-Down Resistor Electrical Characteristics	131

Table 49: CMOS Output Port Electrical Characteristics	131
Table 50: PECL Input / Output Port Electrical Characteristics	133
Table 51: LVDS Input / Output Port Electrical Characteristics	134
Table 52: Output Clock Jitter Generation	136
Table 53: Output Clock Phase Noise	137
Table 54: Input Jitter Tolerance (155.52 MHz)	137
Table 55: Input Jitter Tolerance (1.544 MHz)	137
Table 56: Input Jitter Tolerance (2.048 MHz)	137
Table 57: Input Jitter Tolerance (8 kHz)	137
Table 58: T0 DPLL Jitter Transfer & Damping Factor	138
Table 59: T4 DPLL Jitter Transfer & Damping Factor	138
Table 60: Input/Output Clock Timing 3	140
Table 61: Output Clock Timing	141



List of Figures

Figure 1. Functional Block Diagram	11
Figure 2. Pin Assignment (Top View)	12
Figure 3. Pre-Divider for An Input Clock	20
Figure 4. Input Clock Activity Monitoring	21
Figure 5. External Fast Selection	23
Figure 6. Qualified Input Clocks for Automatic Selection	24
Figure 7. T0 Selected Input Clock vs. DPLL Automatic Operating Mode	30
Figure 8. T4 Selected Input Clock vs. DPLL Automatic Operating Mode	31
Figure 9. On Target Frame Sync Input Signal Timing	39
Figure 10. 0.5 UI Early Frame Sync Input Signal Timing	39
Figure 11. 0.5 UI Late Frame Sync Input Signal Timing	40
Figure 12. 1 UI Late Frame Sync Input Signal Timing	40
Figure 13. 1 UI Late Frame Sync 2K/8K Pulse Input Signal Timing	40
Figure 14. On Target Frame Sync 2K/8K Pulse Input Signal Timing	40
Figure 15. Physical Connection Between Two Devices	42
Figure 16. IDT82V3285A Power Decoupling Scheme	44
Figure 17. Typical Application	45
Figure 18. EPROM Access Timing Diagram	47
Figure 19. Multiplexed Read Timing Diagram	48
Figure 20. Multiplexed Write Timing Diagram	49
Figure 21. Intel Read Timing Diagram	50
Figure 22. Intel Write Timing Diagram	51
Figure 23. Motorola Read Timing Diagram	52
Figure 24. Motorola Write Timing Diagram	53
Figure 25. Serial Read Timing Diagram (CLKE Asserted Low)	54
Figure 26. Serial Read Timing Diagram (CLKE Asserted High)	54
Figure 27. Serial Write Timing Diagram	55
Figure 28. JTAG Interface Timing Diagram	56
Figure 29. Assembly for Expose Pad thermal Release Path (Side View)	129
Figure 30. Recommended PECL Input Port Line Termination	132
Figure 31. Recommended PECL Output Port Line Termination	132
Figure 32. Recommended LVDS Input Port Line Termination	134
Figure 33. Recommended LVDS Output Port Line Termination	134
Figure 34. Example of Single-Ended Signal to Drive Differential Input	135
Figure 35. Output Wander Generation	139
Figure 36. Input / Output Clock Timing	140
Figure 37. Output Clock Timing	141
Figure 38. 100-Pin EQG Package Dimensions (a) (in Millimeters)	146
Figure 39. 100-Pin EQG Package Dimensions (b) (in Millimeters)	147
Figure 40. EQG100 Recommended Land Pattern with Exposed Pad (in Millimeters)	148

FEATURES

HIGHLIGHTS

- The first single PLL chip:
 - Features 0.5 mHz to 560 Hz bandwidth
 - Exceeds GR-253-CORE (OC-12) and ITU-T G.813 (STM-16/Option I) jitter generation requirements
 - Provides node clocks for Cellular and WLL base-station (GSM and 3G networks)
 - Provides clocks for DSL access concentrators (DSLAM), especially for Japan TCM-ISDN network timing based ADSL equipments

MAIN FEATURES

- Provides an integrated single-chip solution for Synchronous Equipment Timing Source, including Stratum 2, 3E, 3, SMC, 4E and 4 clocks
- Employs DPLL and APLL to feature excellent jitter performance and minimize the number of the external components
- Integrates T0 DPLL and T4 DPLL; T4 DPLL locks independently or locks to T0 DPLL
- Supports Forced or Automatic operating mode switch controlled by an internal state machine; the primary operating modes are Free-Run, Locked and Holdover
- Supports programmable DPLL bandwidth (0.5 mHz to 560 Hz in 19 steps) and damping factor (1.2 to 20 in 5 steps)
- Supports 1.1×10^{-5} ppm absolute holdover accuracy and 4.4×10^{-8} ppm instantaneous holdover accuracy
- Supports PBO to minimize phase transients on T0 DPLL output to be no more than 0.61 ns
- Supports phase absorption when phase-time changes on T0 selected input clock are greater than a programmable limit over an interval of less than 0.1 seconds
- Supports programmable input-to-output phase offset adjustment
- Limits the phase and frequency offset of the outputs
- Supports manual and automatic selected input clock switch
- Supports automatic hitless selected input clock switch on clock failure
- Supports three types of input clock sources: recovered clock from STM-N or OC-n, PDH network synchronization timing and external synchronization reference timing
- Provides a 2 kHz, 4 kHz or 8 kHz frame sync input signal, and a 2 kHz and an 8 kHz frame sync output signals
- Provides 5 input clocks whose frequency cover from 2 kHz to 622.08 MHz
- Provides 5 output clocks whose frequency cover from 1 Hz to 622.08 MHz
- Provides output clocks for BITS, GPS, 3G, GSM, etc.
- Supports PECL/LVDS and CMOS input/output technologies
- Supports master clock calibration
- Supports Master/Slave application (two chips used together) to enable system protection against single chip failure
- Meets Telcordia GR-1244-CORE, GR-253-CORE, GR-1377-CORE, ITU-T G.812, ITU-T G.813 and ITU-T G.783 criteria

OTHER FEATURES

- Multiple microprocessor interface modes: EPROM, Multiplexed, Intel, Motorola and Serial
- IEEE 1149.1 JTAG Boundary Scan
- Single 3.3 V operation with 5 V tolerant CMOS I/Os
- 100-pin TQFP package, Green package options available

APPLICATIONS

- BITS / SSU
- SMC / SEC (SONET / SDH)
- DWDM cross-connect and transmission equipments
- Central Office Timing Source and Distribution
- Core and access IP switches / routers
- Gigabit and Terabit IP switches / routers
- IP and ATM core switches and access equipments
- Cellular and WLL base-station node clocks
- Broadband and multi-service access equipments
- Any other telecom equipments that need synchronous equipment system timing

DESCRIPTION

The IDT82V3285A is an integrated, single-chip solution for the Synchronous Equipment Timing Source for Stratum 2, 3E, 3, SMC, 4E and 4 clocks in SONET / SDH equipments, DWDM and Wireless base station, such as GSM, 3G, DSL concentrator, Router and Access Network applications.

The device supports three types of input clock sources: recovered clock from STM-N or OC-n, PDH network synchronization timing and external synchronization reference timing.

Based on ITU-T G.783 and Telcordia GR-253-CORE, the device consists of T0 and T4 paths. The T0 path is a high quality and highly configurable path to provide system clock for node timing synchronization within a SONET / SDH network. The T4 path is simpler and less configurable for equipment synchronization. The T4 path locks independently from the T0 path or locks to the T0 path.

An input clock is automatically or manually selected for T0 and T4 each for DPLL locking. Both the T0 and T4 paths support three primary operating modes: Free-Run, Locked and Holdover. In Free-Run mode, the DPLL refers to the master clock. In Locked mode, the DPLL locks to the selected input clock. In Holdover mode, the DPLL resorts to the fre-

quency data acquired in Locked mode. Whatever the operating mode is, the DPLL gives a stable performance without being affected by operating conditions or silicon process variations.

If the DPLL outputs are processed by T0/T4 APLL, the outputs of the device will be in a better jitter/wander performance.

The device provides programmable DPLL bandwidths: 0.5 mHz to 560 Hz in 19 steps and damping factors: 1.2 to 20 in 5 steps. Different settings cover all SONET / SDH clock synchronization requirements.

A high stable input is required for the master clock in different applications. The master clock is used as a reference clock for all the internal circuits in the device. It can be calibrated within ± 741 ppm.

All the read/write registers are accessed through a microprocessor interface. The device supports five microprocessor interface modes: EPROM, Multiplexed, Intel, Motorola and Serial.

In general, the device can be used in Master/Slave application. In this application, two devices should be used together to enable system protection against single chip failure. See [Chapter 4 Typical Application](#) for details.

FUNCTIONAL BLOCK DIAGRAM

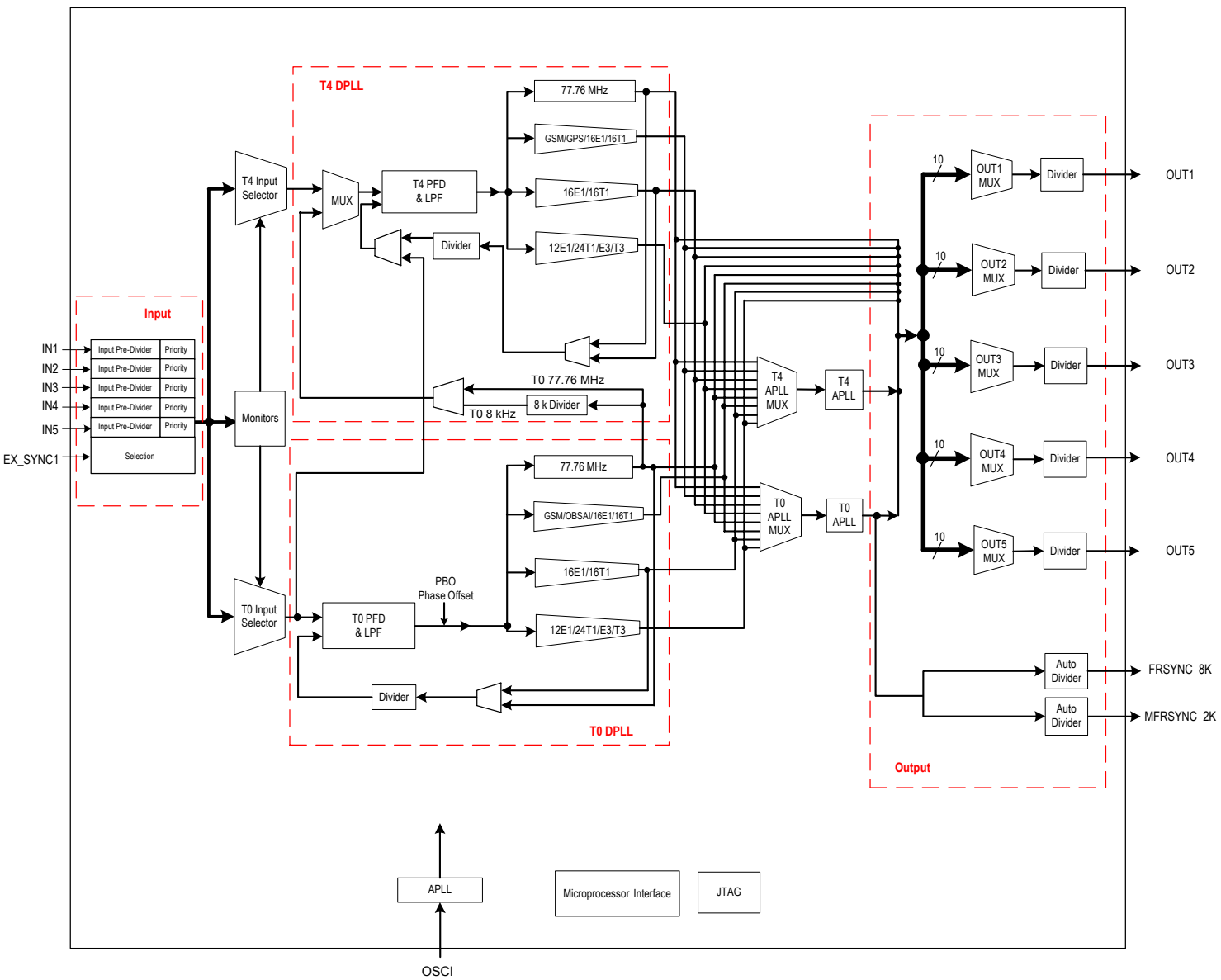


Figure 1. Functional Block Diagram

1 PIN ASSIGNMENT

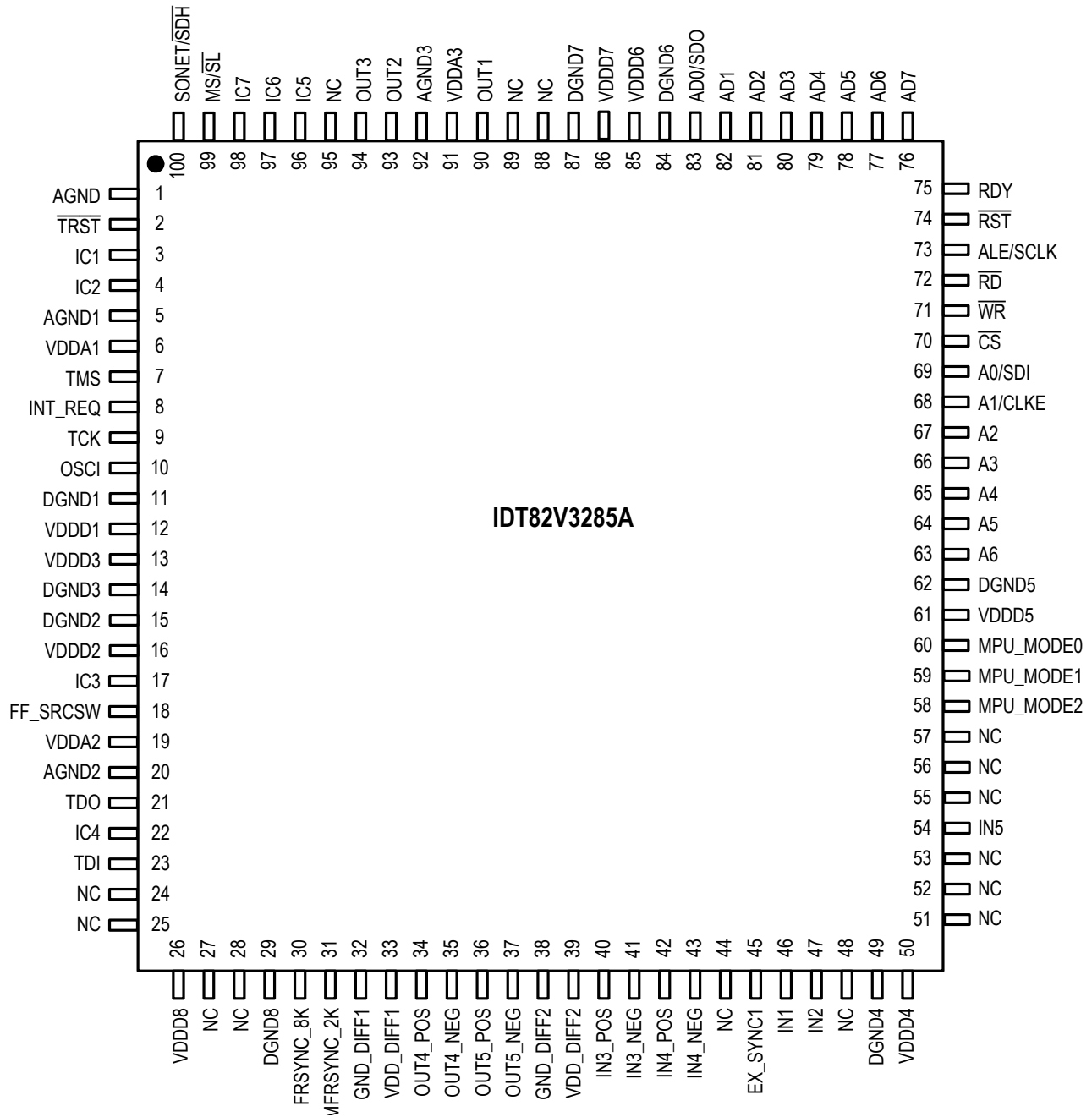


Figure 2. Pin Assignment (Top View)

2 PIN DESCRIPTION

Table 1: Pin Description

Name	Pin No.	I/O	Type	Description ¹
Global Control Signal				
OSCI	10	I	CMOS	OSCI: Crystal Oscillator Master Clock A nominal 12.8000 MHz clock provided by a crystal oscillator is input on this pin. It is the master clock for the device.
FF_SRC SW	18	I pull-down	CMOS	FF_SRC SW: External Fast Selection Enable During reset, this pin determines the default value of the EXT_SW bit (b4, 0BH) ² . The EXT_SW bit determines whether the External Fast Selection is enabled. High: The default value of the EXT_SW bit (b4, 0BH) is '1' (External Fast selection is enabled); Low: The default value of the EXT_SW bit (b4, 0BH) is '0' (External Fast selection is disabled). After reset, this pin selects an input clock pair for the T0 DPLL if the External Fast selection is enabled: High: Pair IN1 / IN3 is selected. Low: Pair IN2/ IN4 is selected. After reset, the input on this pin takes no effect if the External Fast selection is disabled.
MS/SL	99	I pull-up	CMOS	MS/SL: Master / Slave Selection This pin, together with the MS_SL_CTRL bit (b0, 13H), controls whether the device is configured as the Master or as the Slave. Refer to Chapter 3.14 Master / Slave Configuration for details. The signal level on this pin is reflected by the MASTER_SLAVE bit (b1, 09H).
SONET/SDH	100	I pull-down	CMOS	SONET/SDH: SONET / SDH Frequency Selection During reset, this pin determines the default value of the IN_SONET_SDH bit (b2, 09H): High: The default value of the IN_SONET_SDH bit is '1' (SONET); Low: The default value of the IN_SONET_SDH bit is '0' (SDH). After reset, the value on this pin takes no effect.
RST	74	I pull-up	CMOS	RST: Reset A low pulse of at least 50 μ s on this pin resets the device. After this pin is high, the device will still be held in reset state for 500 ms (typical).
Frame Synchronization Input Signal				
EX_SYNC1	45	I pull-down	CMOS	EX_SYNC1: External Sync Input 1 A 2 kHz, 4 kHz or 8 kHz signal is input on this pin.
Input Clock				
IN1	46	I pull-down	CMOS	IN1: Input Clock 1 A 2 kHz, 4 kHz, N x 8 kHz ³ , 1.544 MHz (SONET) / 2.048 MHz (SDH), 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz or 155.52 MHz clock is input on this pin.
IN2	47	I pull-down	CMOS	IN2: Input Clock 2 A 2 kHz, 4 kHz, N x 8 kHz ³ , 1.544 MHz (SONET) / 2.048 MHz (SDH), 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz or 155.52 MHz clock is input on this pin.
IN3_POS IN3_NEG	40 41	I	PECL/LVDS	IN3_POS / IN3_NEG: Positive / Negative Input Clock 3 A 2 kHz, 4 kHz, N x 8 kHz ³ , 1.544 MHz (SONET) / 2.048 MHz (SDH), 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz, 155.52 MHz, 311.04 MHz or 622.08 MHz clock is differentially input on this pair of pins. Whether the clock signal is PECL or LVDS is automatically detected. Single-ended input for differential input is also supported. Refer to Chapter 9.3.2.3 Single-Ended Input for Differential Input .

Table 1: Pin Description (Continued)

Name	Pin No.	I/O	Type	Description ¹
IN4_POS IN4_NEG	42 43	I	PECL/LVDS	IN4_POS / IN4_NEG: Positive / Negative Input Clock 4 A 2 kHz, 4 kHz, N x 8 kHz ³ , 1.544 MHz (SONET) / 2.048 MHz (SDH), 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz, 155.52 MHz, 311.04 MHz or 622.08 MHz clock is differentially input on this pair of pins. Whether the clock signal is PECL or LVDS is automatically detected. Single-ended input for differential input is also supported. Refer to Chapter 9.3.2.3 Single-Ended Input for Differential Input .
IN5	54	I pull-down	CMOS	IN5: Input Clock 5 A 2 kHz, 4 kHz, N x 8 kHz ³ , 1.544 MHz (SONET) / 2.048 MHz (SDH), 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz or 155.52 MHz clock is input on this pin. In Slave operation, the frequency of the T0 selected input clock IN5 is recommended to be 6.48 MHz.
Output Frame Synchronization Signal				
FRSYNC_8K	30	O	CMOS	FRSYNC_8K: 8 kHz Frame Sync Output An 8 kHz signal is output on this pin.
MFRSYNC_2K	31	O	CMOS	MFRSYNC_2K: 2 kHz Multiframe Sync Output A 2 kHz signal is output on this pin.
Output Clock				
OUT1	90	O	CMOS	OUT1: Output Clock 1 A 1 Hz, 400 Hz, 2 kHz, 8 kHz, 64 kHz, N x E1 ⁴ , N x T1 ⁵ , N x 13.0 MHz ⁶ , N x 3.84 MHz ⁷ , 5 MHz, 10 MHz, 20 MHz, E3, T3, 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz or 155.52 MHz clock is output on this pin.
OUT2	93	O	CMOS	OUT2: Output Clock 2 A 1 Hz, 400 Hz, 2 kHz, 8 kHz, 64 kHz, N x E1 ⁴ , N x T1 ⁵ , N x 13.0 MHz ⁶ , N x 3.84 MHz ⁷ , 5 MHz, 10 MHz, 20 MHz, E3, T3, 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz or 155.52 MHz clock is output on this pin.
OUT3	94	O	CMOS	OUT3: Output Clock 3 A 1 Hz, 400 Hz, 2 kHz, 8 kHz, 64 kHz, N x E1 ⁴ , N x T1 ⁵ , N x 13.0 MHz ⁶ , N x 3.84 MHz ⁷ , 5 MHz, 10 MHz, 20 MHz, E3, T3, 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz or 155.52 MHz clock is output on this pin.
OUT4_POS OUT4_NEG	34 35	O	PECL/LVDS	OUT4_POS / OUT4_NEG: Positive / Negative Output Clock 4 A 1 Hz, 400 Hz, 2 kHz, 8 kHz, 64 kHz, N x E1 ⁴ , N x T1 ⁵ , N x 13.0 MHz ⁶ , N x 3.84 MHz ⁷ , 5 MHz, 10 MHz, 20 MHz, E3, T3, 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz, 155.52 MHz, 311.04 MHz or 622.08 MHz clock is differentially output on this pair of pins.
OUT5_POS OUT5_NEG	36 37	O	PECL/LVDS	OUT5_POS / OUT5_NEG: Positive / Negative Output Clock 5 A 1 Hz, 400 Hz, 2 kHz, 8 kHz, 64 kHz, N x E1 ⁴ , N x T1 ⁵ , N x 13.0 MHz ⁶ , N x 3.84 MHz ⁷ , 5 MHz, 10 MHz, 20 MHz, E3, T3, 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz, 155.52 MHz, 311.04 MHz or 622.08 MHz clock is differentially output on this pair of pins.
Microprocessor Interface				
$\overline{\text{CS}}$	70	I pull-up	CMOS	$\overline{\text{CS}}$: Chip Selection A transition from high to low must occur on this pin for each read or write operation and this pin should remain low until the operation is over.
INT_REQ	8	O	CMOS	INT_REQ: Interrupt Request This pin is used as an interrupt request. The output characteristics are determined by the HZ_EN bit (b1, 0CH) and the INT_POL bit (b0, 0CH).

Table 1: Pin Description (Continued)

Name	Pin No.	I/O	Type	Description ¹
MPU_MODE0	60	I pull-down	CMOS	MPU_MODE[2:0]: Microprocessor Interface Mode Selection The device supports five microprocessor interface modes: EPROM, Multiplexed, Intel, Motorola and Serial. During reset, these pins determine the default value of the MPU_SEL_CNFG[2:0] bits (b2~0, 7FH) as follows: 001 (EPROM mode); 010 (Multiplexed mode); 011 (Intel mode); 100 (Motorola mode); 101 (Serial mode); 110 - 111 (Reserved). After reset, these pins are general purpose inputs. The microprocessor interface mode is selected by the MPU_SEL_CNFG[2:0] bits (b2~0, 7FH). The value of these pins is always reflected by the MPU_PIN_STS[2:0] bits (b2~0, 02H).
MPU_MODE1	59			
MPU_MODE2	58			
A0 / SDI	69	I pull-down	CMOS	A[6:0]: Address Bus In EPROM, Intel and Motorola modes, these pins are the address bus of the microprocessor interface. SDI: Serial Data Input In Serial mode, this pin is used as the serial data input. Address and data on this pin are serially clocked into the device on the rising edge of SCLK. CLKE: SCLK Active Edge Selection In Serial mode, this pin selects the active edge of SCLK to update the SDO: High - The falling edge; Low - The rising edge. In Multiplexed mode, A0/SDI, A1/CLKE and A[6:2] pins should be connected to ground. In Serial mode, A[6:2] pins should be connected to ground.
A1 / CLKE	68			
A2	67			
A3	66			
A4	65			
A5	64			
A6	63			
AD0 / SDO	83	I/O pull-down	CMOS	AD[7:0]: Address / Data Bus In EPROM, Intel and Motorola modes, these pins are the bi-directional data bus of the microprocessor interface. In Multiplexed mode, these pins are the bi-directional address/data bus of the microprocessor interface. SDO: Serial Data Output In Serial mode, this pin is used as the serial data output. Data on this pin is serially clocked out of the device on the active edge of SCLK. In Serial mode, AD[7:1] pins should be connected to ground.
AD1	82			
AD2	81			
AD3	80			
AD4	79			
AD5	78			
AD6	77			
AD7	76			
\overline{WR}	71	I pull-up	CMOS	\overline{WR}: Write Operation In Multiplexed and Intel modes, this pin is asserted low to initiate a write operation. In Motorola mode, this pin is asserted low to initiate a write operation or asserted high to initiate a read operation. In EPROM and Serial modes, this pin should be connected to ground.
\overline{RD}	72	I pull-up	CMOS	\overline{RD}: Read Operation In Multiplexed and Intel modes, this pin is asserted low to initiate a read operation. In EPROM, Motorola and Serial modes, this pin should be connected to ground.

Table 1: Pin Description (Continued)

Name	Pin No.	I/O	Type	Description ¹
ALE / SCLK	73	I pull-down	CMOS	<p>ALE: Address Latch Enable In Multiplexed mode, the address on AD[7:0] pins is sampled into the device on the falling edge of ALE.</p> <p>SCLK: Shift Clock In Serial mode, a shift clock is input on this pin. Data on SDI is sampled by the device on the rising edge of SCLK. Data on SDO is updated on the active edge of SCLK. The active edge is determined by the CLKE.</p> <p>In EPROM, Intel and Motorola modes, this pin should be connected to ground.</p>
RDY	75	O	CMOS	<p>RDY: Ready/Data Acknowledge In Multiplexed and Intel modes, a high level on this pin indicates that a read/write cycle is completed. A low level on this pin indicates that wait state must be inserted. In Motorola mode, a low level on this pin indicates that valid information on the data bus is ready for a read operation or acknowledges the acceptance of the written data during a write operation. In EPROM and Serial modes, this pin should be connected to ground.</p>
JTAG (per IEEE 1149.1)				
$\overline{\text{TRST}}$	2	I pull-down	CMOS	<p>$\overline{\text{TRST}}$: JTAG Test Reset (Active Low) A low signal on this pin resets the JTAG test port. This pin should be connected to ground when JTAG is not used.</p>
TMS	7	I pull-up	CMOS	<p>TMS: JTAG Test Mode Select The signal on this pin controls the JTAG test performance and is sampled on the rising edge of TCK.</p>
TCK	9	I pull-down	CMOS	<p>TCK: JTAG Test Clock The clock for the JTAG test is input on this pin. TDI and TMS are sampled on the rising edge of TCK and TDO is updated on the falling edge of TCK. If TCK is idle at a low level, all stored-state devices contained in the test logic will indefinitely retain their state.</p>
TDI	23	I pull-up	CMOS	<p>TDI: JTAG Test Data Input The test data is input on this pin. It is clocked into the device on the rising edge of TCK.</p>
TDO	21	O	CMOS	<p>TDO: JTAG Test Data Output The test data is output on this pin. It is clocked out of the device on the falling edge of TCK. TDO pin outputs a high impedance signal except during the process of data scanning. This pin can indicate the interrupt of T0 selected input clock fail, as determined by the LOS_FLAG_ON_TDO bit (b6, 0BH). Refer to Chapter 3.8.1 Input Clock Validity for details.</p>
Power & Ground				
VDDD1	12	Power	-	<p>VDDDn: 3.3 V Digital Power Supply VDDDn connections should be connected using the recommended decoupling scheme shown in Figure 16.</p>
VDDD2	16			
VDDD3	13			
VDDD4	50			
VDDD5	61			
VDDD6	85			
VDDD7	86			

Table 1: Pin Description (Continued)

Name	Pin No.	I/O	Type	Description ¹
VDDA1	6	Power	-	VDDAn: 3.3 V Analog Power Supply VDDAn connections should be connected using the recommended decoupling scheme shown in Figure 16 .
VDDA2	19			
VDDA3	91			
VDDD8	26	Power	-	VDDD8: 3.3 V Digital Power Supply
VDD_DIFF1	33	Power	-	VDD_DIFF1: 3.3 V Power Supply for OUT4
VDD_DIFF2	39	Power	-	VDD_DIFF2: 3.3 V Power Supply for OUT5
DGND1	11	Ground	-	DGNDn: Digital Ground
DGND2	15			
DGND3	14			
DGND4	49			
DGND5	62			
DGND6	84			
DGND7	87			
AGND1	5	Ground	-	AGNDn: Analog Ground
AGND2	20			
AGND3	92			
GND_DIFF1	32	Ground	-	GND_DIFF: Ground for OUT4
GND_DIFF2	38	Ground	-	GND_DIFF: Ground for OUT5
DGND8	29	Ground	-	DGND8: Digital Ground
AGND	1	Ground	-	AGND: Analog Ground
Others				
IC1	3	-	-	IC: Internally Connected Internal Use. These pins should be left open for normal operation.
IC2	4			
IC3	17			
IC4	22			
IC5	96			
IC6	97			
IC7	98			
NC	24, 25, 27, 28, 44, 48, 51, 52, 53, 55, 56, 57, 88, 89, 95	-	-	NC: Not Connected

Note:

- All the unused input pins should be connected to ground; the output of all the unused output pins are don't-care.
- The contents in the brackets indicate the position of the register bit/bits.
- N x 8 kHz: $1 \leq N \leq 19440$.
- N x E1: N = 1, 2, 3, 4, 6, 8, 12, 16, 24, 32, 48, 64.
- N x T1: N = 1, 2, 3, 4, 6, 8, 12, 16, 24, 32, 48, 64, 96.
- N x 13.0 MHz: N = 1, 2, 4.
- N x 3.84 MHz: N = 1, 2, 4, 8, 16, 10, 20, 40.

3 FUNCTIONAL DESCRIPTION

3.1 RESET

The reset operation resets all registers and state machines to their default value or status.

After power on, the device must be reset for normal operation.

For a complete reset, the $\overline{\text{RST}}$ pin must be asserted low for at least 50 μs . After the $\overline{\text{RST}}$ pin is pulled high, the device will still be in reset state for 500 ms (typical). If the $\overline{\text{RST}}$ pin is held low continuously, the device remains in reset state.

3.2 MASTER CLOCK

A nominal 12.8000 MHz clock, provided by a crystal oscillator, is input on the OSC1 pin. This clock is provided for the device as a master clock. The master clock is used as a reference clock for all the internal circuits. A better active edge of the master clock is selected by the OSC_EDGE bit to improve jitter and wander performance.

In fact, an offset from the nominal frequency may input on the OSC1 pin. This offset can be compensated by setting the NOMINAL_FREQ_VALUE[23:0] bits. The calibration range is within ± 741 ppm.

The performance of the master clock should meet GR-1244-CORE, GR-253-CORE, ITU-T G.812 and G.813 criteria.

Table 2: Related Bit / Register in Chapter 3.2

Bit	Register	Address (Hex)
NOMINAL_FREQ_VALUE[23:0]	NOMINAL_FREQ[23:16]_CNFG, NOMINAL_FREQ[15:8]_CNFG, NOMINAL_FREQ[7:0]_CNFG	06, 05, 04
OSC_EDGE	DIFFERENTIAL_IN_OUT_OSCI_CNFG	0A

3.3 INPUT CLOCKS & FRAME SYNC SIGNAL

Altogether 5 clocks and 1 frame sync signal are input to the device.

3.3.1 INPUT CLOCKS

The device provides 5 input clock ports.

According to the input port technology, the input ports support the following technologies:

- PECL/LVDS
- CMOS

According to the input clock source, the following clock sources are supported:

- T1: Recovered clock from STM-N or OC-n
- T2: PDH network synchronization timing
- T3: External synchronization reference timing

IN1, IN2 and IN5 support CMOS input signal and the clock sources can be from T1, T2 or T3.

IN3 and IN4 support PECL/LVDS input signal and automatically detect whether the signal is PECL or LVDS. The clock sources can be from T1, T2 or T3.

For SDH and SONET networks, the default frequency is different. SONET / SDH frequency selection is controlled by the IN_SONET_SDH bit. During reset, the default value of the IN_SONET_SDH bit is determined by the SONET/SDH pin: high for SONET and low for SDH. After reset, the input signal on the SONET/SDH pin takes no effect.

IDT82V3285A supports single-ended input for differential input. Refer to [Chapter 9.3.2.3 Single-Ended Input for Differential Input](#).

3.3.2 FRAME SYNC INPUT SIGNALS

A 2 kHz, 4 kHz or 8 kHz frame sync signal is input on the EX_SYNC1 pin. It is a CMOS input. The input frequency should match the setting in the SYNC_FREQ[1:0] bits.

The frame sync input signal is used for frame sync output signal synchronization. Refer to [Chapter 3.13.2 Frame SYNC Output Signals](#) for details.

Table 3: Related Bit / Register in Chapter 3.3

Bit	Register	Address (Hex)
IN_SONET_SDH	INPUT_MODE_CNFG	09
SYNC_FREQ[1:0]		

3.4 INPUT CLOCK PRE-DIVIDER

Each input clock is assigned an internal Pre-Divider. The Pre-Divider is used to divide the clock frequency down to the DPLL required frequency, which is no more than 38.88 MHz.

For IN1 ~ IN5, the DPLL required frequency is set by the corresponding IN_FREQ[3:0] bits.

If the input clock is of 2 kHz, 4 kHz or 8 kHz, the Pre-Divider is bypassed automatically and the corresponding IN_FREQ[3:0] bits should be set to match the input frequency; the input clock can be inverted, as determined by the IN_2K_4K_8K_INV bit.

Each Pre-Divider consists of a HF (High Frequency) Divider (only available for IN3 and IN4), a DivN Divider and a Lock 8k Divider, as shown in Figure 3.

The HF Divider, which is only available for IN3 and IN4, should be used when the input clock is higher than (>) 155.52 MHz. The input clock can be divided by 4, 5 or can bypass the HF Divider, as determined by the IN3_DIV[1:0]/IN4_DIV[1:0] bits correspondingly.

Either the DivN Divider or the Lock 8k Divider can be used or both can be bypassed, as determined by the DIRECT_DIV bit and the LOCK_8K bit.

When the DivN Divider is used for INn (1 ≤ n ≤ 5), the division factor setting should observe the following order:

1. Select an input clock by the PRE_DIV_CH_VALUE[3:0] bits;
2. Write the lower eight bits of the division factor to the PRE_DIVN_VALUE[7:0] bits;
3. Write the higher eight bits of the division factor to the PRE_DIVN_VALUE[14:8] bits.

Once the division factor is set for the input clock selected by the PRE_DIV_CH_VALUE[3:0] bits, it is valid until a different division factor is set for the same input clock. The division factor is calculated as follows:

$$\text{Division Factor} = (\text{the frequency of the clock input to the DivN Divider} \div \text{the frequency of the DPLL required clock set by the IN_FREQ[3:0] bits}) - 1$$

The DivN Divider can only divide the input clock whose frequency is lower than (<) 155.52 MHz.

When the Lock 8k Divider is used, the input clock is divided down to 8 kHz automatically.

The Pre-Divider configuration and the division factor setting depend on the input clock on one of the IN1 ~ IN5 pins and the DPLL required clock. Here is an example:

The input clock on the IN4 pin is 622.08 MHz; the DPLL required clock is 6.48 MHz by programming the IN_FREQ[3:0] bits of register IN4 to '0010'. Do the following step by step to divide the input clock:

1. Use the HF Divider to divide the clock down to 155.52 MHz:
622.08 ÷ 155.52 = 4, so set the IN4_DIV[1:0] bits to '01';
2. Use the DivN Divider to divide the clock down to 6.48 MHz:
Set the PRE_DIV_CH_VALUE[3:0] bits to '0110';
Set the DIRECT_DIV bit in Register IN4_CNFG to '1' and the LOCK_8K bit in Register IN4_CNFG to '0';
155.52 ÷ 6.48 = 24; 24 - 1 = 23, so set the PRE_DIVN_VALUE[14:0] bits to '10111'.

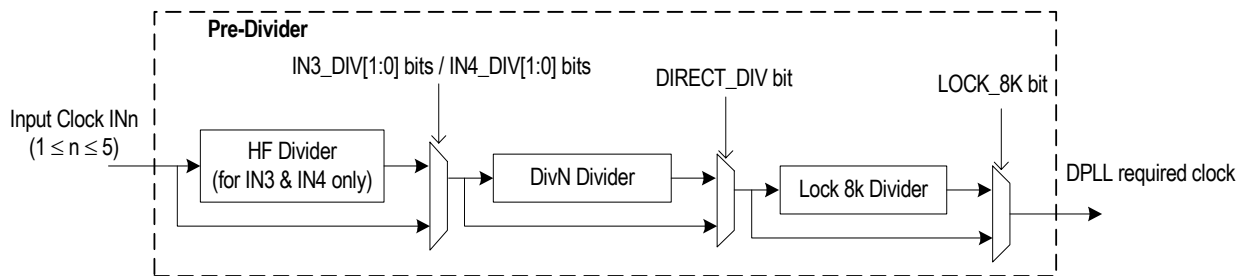


Figure 3. Pre-Divider for An Input Clock

Table 4: Related Bit / Register in Chapter 3.4

Bit	Register	Address (Hex)
IN3_DIV[1:0]	IN3_IN4_HF_DIV_CNFG	18
IN4_DIV[1:0]		
IN_FREQ[3:0]	IN1_CNFG ~ IN5_CNFG	16 ~ 17, 19 ~ 1A, 1F
IN_2K_4K_8K_INV	FR_MFR_SYNC_CNFG	74
DIRECT_DIV	IN1_CNFG ~ IN5_CNFG	16 ~ 17, 19 ~ 1A, 1F
LOCK_8K		
PRE_DIV_CH_VALUE[3:0]	PRE_DIV_CH_CNFG	23
PRE_DIVN_VALUE[14:0]	PRE_DIVN[14:8]_CNFG, PRE_DIVN[7:0]_CNFG	25, 24

3.5 INPUT CLOCK QUALITY MONITORING

The qualities of all the input clocks are always monitored in the following aspects:

- Activity
- Frequency

Activity and frequency monitoring are conducted on all the input clocks.

The qualified clocks are available for T0/T4 DPLL selection. The T0 and T4 selected input clocks have to be monitored further. Refer to [Chapter 3.7 Selected Input Clock Monitoring](#) for details.

3.5.1 ACTIVITY MONITORING

Activity is monitored by using an internal leaky bucket accumulator, as shown in [Figure 4](#).

Each input clock is assigned an internal leaky bucket accumulator. The input clock is monitored for each period of 128 ms and the internal leaky bucket accumulator increases by 1 when an event is detected; it decreases by 1 if no event is detected within the period set by the decay rate. The event is that an input clock drifts outside ($>$) ± 500 ppm with respect to the master clock within a 128 ms period.

There are four configurations (0 - 3) for a leaky bucket accumulator. The leaky bucket configuration for an input clock is selected by the corresponding BUCKET_SEL[1:0] bits. Each leaky bucket configuration consists of four elements: upper threshold, lower threshold, bucket size and decay rate.

The bucket size is the capability of the accumulator. If the number of the accumulated events reaches the bucket size, the accumulator will stop increasing even if further events are detected. The upper threshold is a point above which a no-activity alarm is raised. The lower threshold is a point below which the no-activity alarm is cleared. The decay rate is a certain period during which the accumulator decreases by 1 if no event is detected.

The leaky bucket configuration is programmed by one of four groups of register bits: the BUCKET_SIZE_n_DATA[7:0] bits, the UPPER_THRESHOLD_n_DATA[7:0] bits, the LOWER_THRESHOLD_n_DATA[7:0] bits and the DECAY_RATE_n_DATA[1:0] bits respectively; 'n' is 3.

The no-activity alarm status of the input clock is indicated by the INn_NO_ACTIVITY_ALARM bit ($1 \leq n \leq 5$).

The input clock with a no-activity alarm is disqualified for clock selection for T0/T4 DPLL.

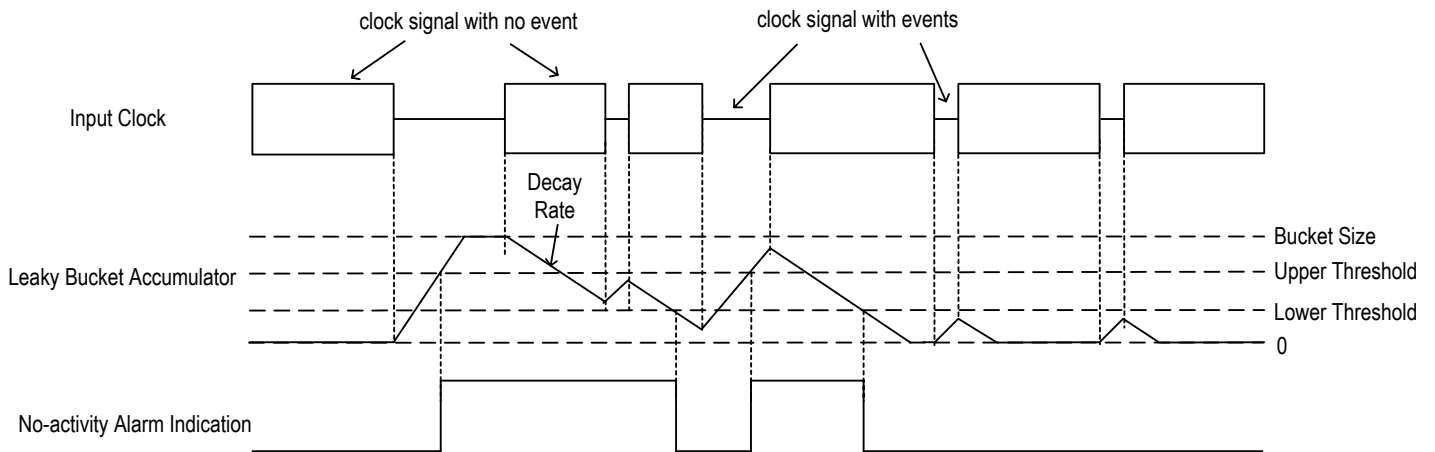


Figure 4. Input Clock Activity Monitoring

3.5.2 FREQUENCY MONITORING

Frequency is monitored by comparing the input clock with a reference clock. The reference clock can be derived from the master clock or the output of T0 DPLL, as determined by the `FREQ_MON_CLK` bit.

A frequency hard alarm threshold is set for frequency monitoring. If the `FREQ_MON_HARD_EN` bit is '1', a frequency hard alarm is raised when the frequency of the input clock with respect to the reference clock is above the threshold; the alarm is cleared when the frequency is below the threshold.

The frequency hard alarm threshold can be calculated as follows:

$$\text{Frequency Hard Alarm Threshold (ppm)} = (\text{ALL_FREQ_HARD_THRESHOLD}[3:0] + 1) \times \text{FREQ_MON_FACTOR}[3:0]$$

If the `FREQ_MON_HARD_EN` bit is '1', the frequency hard alarm status of the input clock is indicated by the `INn_FREQ_HARD_ALARM` bit ($1 \leq n \leq 5$). When the `FREQ_MON_HARD_EN` bit is '0', no frequency hard alarm is raised even if the input clock is above the frequency hard alarm threshold.

The input clock with a frequency hard alarm is disqualified for clock selection for T0/T4 DPLL.

In addition, if the input clock is 2 kHz, 4 kHz or 8 kHz, its clock edges with respect to the reference clock are monitored. If any edge drifts outside $\pm 5\%$, the input clock is disqualified for clock selection for T0/T4 DPLL. The input clock is qualified if any edge drifts inside $\pm 5\%$. This function is supported only when the `IN_NOISE_WINDOW` bit is '1'.

The frequency of each input clock with respect to the reference clock can be read by doing the following step by step:

1. Select an input clock by setting the `IN_FREQ_READ_CH[3:0]` bits;
2. Read the value in the `IN_FREQ_VALUE[7:0]` bits and calculate as follows:

$$\text{Input Clock Frequency (ppm)} = \text{IN_FREQ_VALUE}[7:0] \times \text{FREQ_MON_FACTOR}[3:0]$$

Note that the value set by the `FREQ_MON_FACTOR[3:0]` bits depends on the application.

Table 5: Related Bit / Register in Chapter 3.5

Bit	Register	Address (Hex)
<code>BUCKET_SIZE_n_DATA[7:0]</code> ($n = 3$)	<code>BUCKET_SIZE_3_CNFG</code>	3F
<code>UPPER_THRESHOLD_n_DATA[7:0]</code> ($n = 3$)	<code>UPPER_THRESHOLD_3_CNFG</code>	3D
<code>LOWER_THRESHOLD_n_DATA[7:0]</code> ($n = 3$)	<code>LOWER_THRESHOLD_3_CNFG</code>	3E
<code>DECAY_RATE_n_DATA[1:0]</code> ($n = 3$)	<code>DECAY_RATE_3_CNFG</code>	40
<code>BUCKET_SEL[1:0]</code>	<code>IN1_CNFG ~ IN5_CNFG</code>	16 ~ 17, 19 ~ 1A, 1F
<code>INn_NO_ACTIVITY_ALARM</code> ($1 \leq n \leq 5$)	<code>IN1_IN2_STS, IN3_IN4_STS, IN5_STS</code>	44~ 45, 48
<code>INn_FREQ_HARD_ALARM</code> ($1 \leq n \leq 5$)		
<code>FREQ_MON_CLK</code>	<code>MON_SW_PBO_CNFG</code>	0B
<code>FREQ_MON_HARD_EN</code>		
<code>ALL_FREQ_HARD_THRESHOLD[3:0]</code>	<code>ALL_FREQ_MON_THRESHOLD_CNFG</code>	2F
<code>FREQ_MON_FACTOR[3:0]</code>	<code>FREQ_MON_FACTOR_CNFG</code>	2E
<code>IN_NOISE_WINDOW</code>	<code>PHASE_MON_PBO_CNFG</code>	78
<code>IN_FREQ_READ_CH[3:0]</code>	<code>IN_FREQ_READ_CH_CNFG</code>	41
<code>IN_FREQ_VALUE[7:0]</code>	<code>IN_FREQ_READ_STS</code>	42

3.6 T0 / T4 DPLL INPUT CLOCK SELECTION

An input clock is selected for T0 DPLL and for T4 DPLL respectively.

For T0 path, the EXT_SW bit and the T0_INPUT_SEL[3:0] bits determine the input clock selection, as shown in [Table 6](#):

Table 6: Input Clock Selection for T0 Path

Control Bits		Input Clock Selection
EXT_SW	T0_INPUT_SEL[3:0]	
1	don't-care	External Fast selection
0	other than 0000	Forced selection
	0000	Automatic selection

For T4 path, the T4 DPLL may lock to a T0 DPLL output or lock independently from T0 path, as determined by the T4_LOCK_T0 bit. When the T4 DPLL locks to the T0 DPLL output, the T4 selected input clock is a 77.76 MHz or 8 kHz signal from the T0 DPLL 77.76 MHz path (refer to [Chapter 3.11.5.1 T0 Path](#)), as determined by the T0_FOR_T4 bit. When the T4 path locks independently from the T0 path, the T4 DPLL input clock selection is determined by the T4_INPUT_SEL[3:0] bits. Refer to [Table 7](#):

Table 7: Input Clock Selection for T4 Path

Control Bits - T4_INPUT_SEL[3:0]	Input Clock Selection
other than 0000	Forced selection
0000	Automatic selection

External Fast selection is done between IN1/IN3 and IN2/IN4 pairs.

Forced selection is done by setting the related registers.

Table 8: External Fast Selection

Control Pin & Bits			Selected Input Clock
FF_SRCSW (after reset)	IN1_SEL_PRIORITY[3:0]	IN2_SEL_PRIORITY[3:0]	
high	0000	don't-care	IN3
	other than 0000		IN1
low	don't-care	0000	IN4
		other than 0000	IN2

Automatic selection is done based on the results of input clocks quality monitoring and the related registers configuration.

The selected input clock is attempted to be locked in T0/T4 DPLL.

3.6.1 EXTERNAL FAST SELECTION (T0 ONLY)

The External Fast selection is supported by T0 path only. In External Fast selection, only IN1/IN3 and IN2/IN4 pairs are available for selection. Refer to [Figure 5](#). The results of input clocks quality monitoring (refer to [Chapter 3.5 Input Clock Quality Monitoring](#)) do not affect input clock selection.

The T0 input clock selection is determined by the FF_SRCSW pin after reset (this pin determines the default value of the EXT_SW bit during reset, refer to [Chapter 2 Pin Description](#)), the IN1_SEL_PRIORITY[3:0] bits and the IN2_SEL_PRIORITY[3:0] bits, as shown in [Figure 5](#) and [Table 8](#):

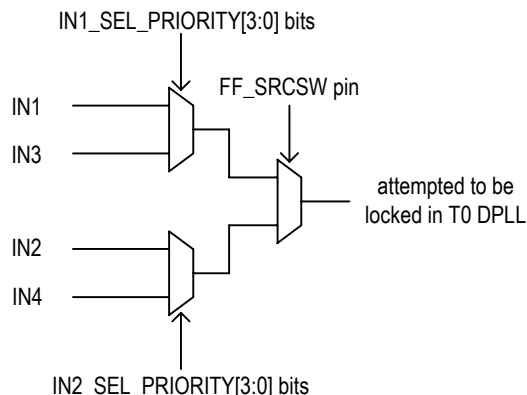


Figure 5. External Fast Selection

3.6.2 FORCED SELECTION

In Forced selection, the selected input clock is set by the T0_INPUT_SEL[3:0] / T4_INPUT_SEL[3:0] bits. The results of input clocks quality monitoring (refer to [Chapter 3.5 Input Clock Quality Monitoring](#)) do not affect the input clock selection.

3.6.3 AUTOMATIC SELECTION

In Automatic selection, the input clock selection is determined by its validity, priority and locking allowance configuration. The validity

depends on the results of input clock quality monitoring (refer to [Chapter 3.5 Input Clock Quality Monitoring](#)). Locking allowance is configured by the corresponding INn_VALID bit ($1 \leq n \leq 5$). Refer to [Figure 6](#). In all the qualified input clocks, the one with the highest priority is selected. The priority is set by the corresponding INn_SEL_PRIORITY[3:0] bits ($1 \leq n \leq 5$). If more than one qualified input clock INn is available and has the same priority, the input clock with the smallest 'n' is selected.

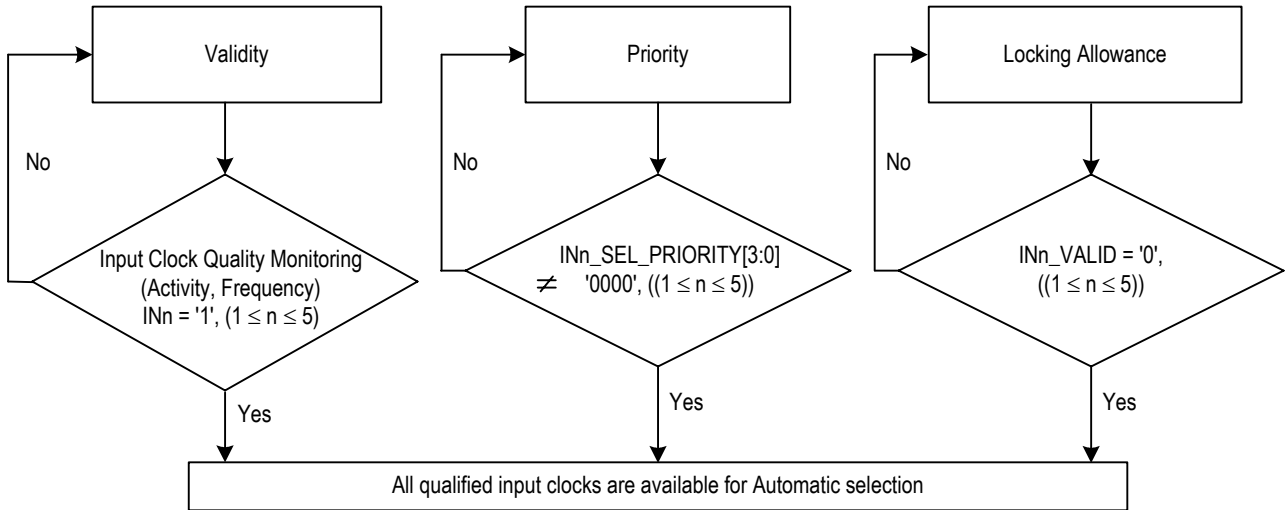


Figure 6. Qualified Input Clocks for Automatic Selection

Table 9: Related Bit / Register in Chapter 3.6

Bit	Register	Address (Hex)
EXT_SW	MON_SW_PBO_CNFG	0B
T0_INPUT_SEL[3:0]	T0_INPUT_SEL_CNFG	50
T4_LOCK_T0	T4_INPUT_SEL_CNFG	51
T0_FOR_T4		
T4_INPUT_SEL[3:0]		
INn_SEL_PRIORITY[3:0] ($1 \leq n \leq 5$)	IN1_IN2_SEL_PRIORITY_CNFG IN3_IN4_SEL_PRIORITY_CNFG IN5_SEL_PRIORITY_CNFG	27 ~ 28, 2B
INn_VALID ($1 \leq n \leq 5$)	REMOTE_INPUT_VALID1_CNFG, REMOTE_INPUT_VALID2_CNFG	4C, 4D
INn ($1 \leq n \leq 5$)	INPUT_VALID1_STS, INPUT_VALID2_STS	4A, 4B
T4_T0_SEL	T4_T0_REG_SEL_CNFG	07

Note: * The setting in the 26 ~ 2C registers is either for T0 path or for T4 path, as determined by the T4_T0_SEL bit.

3.7 SELECTED INPUT CLOCK MONITORING

The quality of the selected input clock is always monitored (refer to [Chapter 3.5 Input Clock Quality Monitoring](#)) and the DPLL locking status is always monitored.

3.7.1 T0 / T4 DPLL LOCKING DETECTION

The following events are always monitored:

- Fast Loss;
- Coarse Phase Loss;
- Fine Phase Loss;
- Hard Limit Exceeding.

3.7.1.1 Fast Loss

A fast loss is triggered when the selected input clock misses 2 consecutive clock cycles. It is cleared once an active clock edge is detected.

For T0 path, the occurrence of the fast loss will result in T0 DPLL being unlocked if the FAST_LOS_SW bit is '1'. For T4 path, the occurrence of the fast loss will result in T4 DPLL being unlocked regardless of the FAST_LOS_SW bit.

3.7.1.2 Coarse Phase Loss

The T0/T4 DPLL compares the selected input clock with the feedback signal. If the phase-compared result exceeds the coarse phase limit, a coarse phase loss is triggered. It is cleared once the phase-compared result is within the coarse phase limit.

When the selected input clock is of 2 kHz, 4 kHz or 8 kHz, the coarse phase limit depends on the MULTI_PH_8K_4K_2K_EN bit, the WIDE_EN bit and the PH_LOS_COARSE_LIMT[3:0] bits. Refer to [Table 10](#). When the selected input clock is of other frequencies than 2 kHz, 4 kHz and 8 kHz, the coarse phase limit depends on the WIDE_EN bit and the PH_LOS_COARSE_LIMT[3:0] bits. Refer to [Table 11](#).

Table 10: Coarse Phase Limit Programming (the selected input clock of 2 kHz, 4 kHz or 8 kHz)

MULTI_PH_8K_4K_2K_EN	WIDE_EN	Coarse Phase Limit
0	don't-care	±1 UI
1	0	±1 UI
	1	set by the PH_LOS_COARSE_LIMT[3:0] bits

Table 11: Coarse Phase Limit Programming (the selected input clock of other than 2 kHz, 4 kHz and 8 kHz)

WIDE_EN	Coarse Phase Limit
0	±1 UI
1	set by the PH_LOS_COARSE_LIMT[3:0] bits

The occurrence of the coarse phase loss will result in T0/T4 DPLL being unlocked if the COARSE_PH_LOS_LIMT_EN bit is '1'.

3.7.1.3 Fine Phase Loss

The T0/T4 DPLL compares the selected input clock with the feedback signal. If the phase-compared result exceeds the fine phase limit programmed by the PH_LOS_FINE_LIMT[2:0] bits, a fine phase loss is triggered. It is cleared once the phase-compared result is within the fine phase limit.

The occurrence of the fine phase loss will result in T0/T4 DPLL being unlocked if the FINE_PH_LOS_LIMT_EN bit is '1'.

3.7.1.4 Hard Limit Exceeding

Two limits are available for this monitoring. They are DPLL soft limit and DPLL hard limit. When the frequency of the DPLL output with respect to the master clock exceeds the DPLL soft / hard limit, a DPLL soft / hard alarm will be raised; the alarm is cleared once the frequency is within the corresponding limit. The occurrence of the DPLL soft alarm does not affect the T0/T4 DPLL locking status. The DPLL soft alarm is indicated by the corresponding T0_DPLL_SOFT_FREQ_ALARM / T4_DPLL_SOFT_FREQ_ALARM bit. The occurrence of the DPLL hard alarm will result in T0/T4 DPLL being unlocked if the FREQ_LIMT_PH_LOS bit is '1'.

The DPLL soft limit is set by the DPLL_FREQ_SOFT_LIMT[6:0] bits and can be calculated as follows:

$$DPLL \text{ Soft Limit (ppm)} = DPLL_FREQ_SOFT_LIMT[6:0] \times 0.724$$

The DPLL hard limit is set by the DPLL_FREQ_HARD_LIMT[15:0] bits and can be calculated as follows:

$$DPLL \text{ Hard Limit (ppm)} = DPLL_FREQ_HARD_LIMT[15:0] \times 0.0014$$

3.7.2 LOCKING STATUS

The DPLL locking status depends on the locking monitoring results. The DPLL is in locked state if none of the following events is triggered during 2 seconds; otherwise, the DPLL is unlocked.

- Fast Loss (the FAST_LOS_SW bit is '1');
- Coarse Phase Loss (the COARSE_PH_LOS_LIMT_EN bit is '1');
- Fine Phase Loss (the FINE_PH_LOS_LIMT_EN bit is '1');
- DPLL Hard Alarm (the FREQ_LIMT_PH_LOS bit is '1').

If the FAST_LOS_SW bit, the COARSE_PH_LOS_LIMT_EN bit, the FINE_PH_LOS_LIMT_EN bit or the FREQ_LIMT_PH_LOS bit is '0', the DPLL locking status will not be affected even if the corresponding event is triggered. If all these bits are '0', the DPLL will be in locked state in 2 seconds.

The DPLL locking status is indicated by the T0_DPLL_LOCK / T4_DPLL_LOCK bit.

The T4_STS¹ bit will be set when the locking status of the T4 DPLL changes (from 'locked' to 'unlocked' or from 'unlocked' to 'locked'). If the T4_STS² bit is '1', an interrupt will be generated.