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SYNCHRONOUS ETHERNET

WAN PLL

IDT82V3380

NRND - Not Recommend for New Designs

FOR REPLACEMENT DEVICE USE IDT82V3380A

Version 3
September 29, 2014

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Table of Contents

NRND - Not Recommend for New Designs

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 19
3.1 RESET 19
3.2 MASTER CLOCK 19
3.3 INPUT CLOCKS & FRAME SYNC SIGNAL 20
3.3.1 Input Clocks 20
3.3.2 Frame SYNC Input Signals 20
3.4 INPUT CLOCK PRE-DIVIDER 21
3.5 INPUT CLOCK QUALITY MONITORING 23
3.5.1 LOS Monitoring 23
3.5.2 Activity Monitoring 23
3.5.3 Frequency Monitoring 24
3.6 T0 / T4 DPLL INPUT CLOCK SELECTION 25
3.6.1 External Fast Selection (T0 only) 25
3.6.2 Forced Selection 26
3.6.3 Automatic Selection 26
3.7 SELECTED INPUT CLOCK MONITORING 27
3.7.1 T0 / T4 DPLL Locking Detection 27
3.7.1.1 Fast Loss 27
3.7.1.2 Coarse Phase Loss 27
3.7.1.3 Fine Phase Loss 27
3.7.1.4 Hard Limit Exceeding 27
3.7.2 Locking Status 27
3.7.3 Phase Lock Alarm (T0 only) 28
3.8 SELECTED INPUT CLOCK SWITCH 29
3.8.1 Input Clock Validity 29
3.8.2 Selected Input Clock Switch 29
3.8.2.1 Revertive Switch 29
3.8.2.2 Non-Revertive Switch (T0 only) 30
3.8.3 Selected / Qualified Input Clocks Indication 30
3.9 SELECTED INPUT CLOCK STATUS VS. DPLL OPERATING MODE 31
3.9.1 T0 Selected Input Clock vs. DPLL Operating Mode 31
3.9.2 T4 Selected Input Clock vs. DPLL Operating Mode 33
3.10 T0 / T4 DPLL OPERATING MODE 34
3.10.1 T0 DPLL Operating Mode 34
3.10.1.1 Free-Run Mode 34
3.10.1.2 Pre-Locked Mode 34
3.10.1.3 Locked Mode 34

3.10.1.3.1 Temp-Holdover Mode 34
3.10.1.4 Lost-Phase Mode 34
3.10.1.5 Holdover Mode 34
3.10.1.5.1 Automatic Instantaneous 35
3.10.1.5.2 Automatic Slow Averaged 35
3.10.1.5.3 Automatic Fast Averaged 35
3.10.1.5.4 Manual 35
3.10.1.5.5 Holdover Frequency Offset Read 35
3.10.1.6 Pre-Locked2 Mode 35
3.10.2 T4 DPLL Operating Mode 35
3.10.2.1 Free-Run Mode 35
3.10.2.2 Locked Mode 35
3.10.2.3 Holdover Mode 35
3.11 T0 / T4 DPLL OUTPUT 37
3.11.1 PFD Output Limit 37
3.11.2 Frequency Offset Limit 37
3.11.3 PBO (T0 only) 37
3.11.4 Phase Offset Selection (T0 only) 37
3.11.5 Four Paths of T0 / T4 DPLL Outputs 37
3.11.5.1 T0 Path 37
3.11.5.2 T4 Path 38
3.12 T0 / T4 APLL 39
3.13 OUTPUT CLOCKS & FRAME SYNC SIGNALS 39
3.13.1 Output Clocks 39
3.13.2 Frame SYNC Output Signals 44
3.14 MASTER / SLAVE CONFIGURATION 46
3.15 INTERRUPT SUMMARY 47
3.16 T0 AND T4 SUMMARY 47
3.17 POWER SUPPLY FILTERING TECHNIQUES 48
4 TYPICAL APPLICATION 49
4.1 MASTER / SLAVE APPLICATION 49
5 MICROPROCESSOR INTERFACE 50
5.1 EPROM MODE 51
5.2 MULTIPLEXED MODE 52
5.3 INTEL MODE 54
5.4 MOTOROLA MODE 56
5.5 SERIAL MODE 58
6 JTAG 60
7 PROGRAMMING INFORMATION 61
7.1 REGISTER MAP 61
7.2 REGISTER DESCRIPTION 67
7.2.1 Global Control Registers 67
7.2.2 Interrupt Registers 76
7.2.3 Input Clock Frequency & Priority Configuration Registers 82
7.2.4 Input Clock Quality Monitoring Configuration & Status Registers 108
7.2.5 T0 / T4 DPLL Input Clock Selection Registers 122
7.2.6 T0 / T4 DPLL State Machine Control Registers 128
7.2.7 T0 / T4 DPLL & APLL Configuration Registers 130
7.2.8 Output Configuration Registers 144
7.2.9 PBO & Phase Offset Control Registers 154
7.2.10 Synchronization Configuration Registers 156
8 THERMAL MANAGEMENT 158
8.1 JUNCTION TEMPERATURE 158

8.2 EXAMPLE OF JUNCTION TEMPERATURE CALCULATION 158
8.3 HEATSINK EVALUATION 158
8.4 TQFP EPAD THERMAL RELEASE PATH 159
9 ELECTRICAL SPECIFICATIONS 160
9.1 ABSOLUTE MAXIMUM RATING 160
9.2 RECOMMENDED OPERATION CONDITIONS 160
9.3 I/O SPECIFICATIONS 161
9.3.1 AMI Input / Output Port 161
9.3.1.1 Structure 161
9.3.1.2 I/O Level 161
9.3.1.3 Over-Voltage Protection 163
9.3.2 CMOS Input / Output Port 163
9.3.3 PECL / LVDS Input / Output Port 164
9.3.3.1 PECL Input / Output Port 164
9.3.3.2 LVDS Input / Output Port 166
9.4 JITTER & WANDER PERFORMANCE 167
9.5 OUTPUT WANDER GENERATION 170
9.6 INPUT / OUTPUT CLOCK TIMING 171
9.7 OUTPUT CLOCK TIMING 172
.... 178
.... 179
PACKAGE DIMENSIONS 180
ORDERING INFORMATION 184

List of Tables

Table 1: Pin Description 13
Table 2: Related Bit / Register in Chapter 3.2 19
Table 3: Related Bit / Register in Chapter 3.3 20
Table 4: Related Bit / Register in Chapter 3.4 22
Table 5: Related Bit / Register in Chapter 3.5 24
Table 6: Input Clock Selection for T0 Path 25
Table 7: Input Clock Selection for T4 Path 25
Table 8: External Fast Selection 25
Table 9: Related Bit / Register in Chapter 3.6 26
Table 10: Coarse Phase Limit Programming (the selected input clock of 2 kHz, 4 kHz or 8 kHz) 27
Table 11: Coarse Phase Limit Programming (the selected input clock of other than 2 kHz, 4 kHz and 8 kHz) 27
Table 12: Related Bit / Register in Chapter 3.7 28
Table 13: Conditions of Qualified Input Clocks Available for T0 & T4 Selection 29
Table 14: Related Bit / Register in Chapter 3.8 30
Table 15: T0 DPLL Operating Mode Control 31
Table 16: T4 DPLL Operating Mode Control 33
Table 17: Related Bit / Register in Chapter 3.9 33
Table 18: Frequency Offset Control in Temp-Holdover Mode 34
Table 19: Frequency Offset Control in Holdover Mode 35
Table 20: Holdover Frequency Offset Read 35
Table 21: Related Bit / Register in Chapter 3.10 36
Table 22: Related Bit / Register in Chapter 3.11 38
Table 23: Related Bit / Register in Chapter 3.12 39
Table 24: Outputs on OUT1 ~ OUT7 if Derived from T0/T4 DPLL Outputs 40
Table 25: Outputs on OUT1 ~ OUT7 if Derived from T0 APLL 41
Table 26: Outputs on OUT1 & 2 & 4 & 5 & 6 if Derived from T4 APLL 42
Table 27: Outputs on OUT3 & OUT7 if Derived from T4 APLL 43
Table 28: Outputs on OUT8 & OUT9 43
Table 29: Synchronization Control 44
Table 30: Related Bit / Register in Chapter 3.13 45
Table 31: Device Master / Slave Control 46
Table 32: Related Bit / Register in Chapter 3.15 47
Table 33: Microprocessor Interface 50
Table 34: Access Timing Characteristics in EPROM Mode 51
Table 35: Read Timing Characteristics in Multiplexed Mode 52
Table 36: Write Timing Characteristics in Multiplexed Mode 53
Table 37: Read Timing Characteristics in Intel Mode 54
Table 38: Write Timing Characteristics in Intel Mode 55
Table 39: Read Timing Characteristics in Motorola Mode 56
Table 40: Write Timing Characteristics in Motorola Mode 57
Table 41: Read Timing Characteristics in Serial Mode 58
Table 42: Write Timing Characteristics in Serial Mode 59
Table 43: JTAG Timing Characteristics 60
Table 44: Register List and Map 61
Table 45: Power Consumption and Maximum Junction Temperature 158
Table 46: Thermal Data 158
Table 47: Absolute Maximum Rating 160
Table 48: Recommended Operation Conditions 160

Table 49: AMI Input / Output Port Electrical Characteristics 162
Table 50: CMOS Input Port Electrical Characteristics 163
Table 51: CMOS Input Port with Internal Pull-Up Resistor Electrical Characteristics 163
Table 52: CMOS Input Port with Internal Pull-Down Resistor Electrical Characteristics 163
Table 53: CMOS Output Port Electrical Characteristics 163
Table 54: PECL Input / Output Port Electrical Characteristics 165
Table 55: LVDS Input / Output Port Electrical Characteristics 166
Table 56: Output Clock Jitter Generation 167
Table 57: Output Clock Phase Noise 168
Table 58: Input Jitter Tolerance (155.52 MHz) 168
Table 59: Input Jitter Tolerance (1.544 MHz) 168
Table 60: Input Jitter Tolerance (2.048 MHz) 168
Table 61: Input Jitter Tolerance (8 kHz) 168
Table 62: T0 DPLL Jitter Transfer & Damping Factor 169
Table 63: T4 DPLL Jitter Transfer & Damping Factor 169
Table 64: Input/Output Clock Timing 3 171
Table 65: Output Clock Timing 173

List of Figures

Figure 1. Functional Block Diagram 11
Figure 2. Pin Assignment (Top View) 12
Figure 3. Pre-Divider for An Input Clock 21
Figure 4. Input Clock Activity Monitoring 23
Figure 5. External Fast Selection 25
Figure 6. Qualified Input Clocks for Automatic Selection 26
Figure 7. T0 Selected Input Clock vs. DPLL Automatic Operating Mode 32
Figure 8. T4 Selected Input Clock vs. DPLL Automatic Operating Mode 33
Figure 9. On Target Frame Sync Input Signal Timing 44
Figure 10. 0.5 UI Early Frame Sync Input Signal Timing 44
Figure 11. 0.5 UI Late Frame Sync Input Signal Timing 45
Figure 12. 1 UI Late Frame Sync Input Signal Timing 45
Figure 13. Physical Connection Between Two Devices 46
Figure 14. IDT82V3380 Power Decoupling Scheme 48
Figure 15. Typical Application 49
Figure 16. EPROM Access Timing Diagram 51
Figure 17. Multiplexed Read Timing Diagram 52
Figure 18. Multiplexed Write Timing Diagram 53
Figure 19. Intel Read Timing Diagram 54
Figure 20. Intel Write Timing Diagram 55
Figure 21. Motorola Read Timing Diagram 56
Figure 22. Motorola Write Timing Diagram 57
Figure 23. Serial Read Timing Diagram (CLKE Asserted Low) 58
Figure 24. Serial Read Timing Diagram (CLKE Asserted High) 58
Figure 25. Serial Write Timing Diagram 59
Figure 26. JTAG Interface Timing Diagram 60
Figure 27. Assembly for Expose Pad thermal Release Path (Side View) 159
Figure 28. 64 kHz + 8 kHz Signal Structure 161
Figure 29. 64 kHz + 8 kHz + 0.4 kHz Signal Structure 161
Figure 30. 64 kHz + 8 kHz / 64 kHz + 8 kHz + 0.4 kHz Signal Input Level 161
Figure 31. 64 kHz + 8 kHz / 64 kHz + 8 kHz + 0.4 kHz Signal Output Level 161
Figure 32. AMI Input / Output Port Line Termination (Recommended) 162
Figure 33. Recommended PECL Input Port Line Termination 164
Figure 34. Recommended PECL Output Port Line Termination 164
Figure 35. Recommended LVDS Input Port Line Termination 166
Figure 36. Recommended LVDS Output Port Line Termination 166
Figure 37. Output Wander Generation 170
Figure 38. Input / Output Clock Timing 171
Figure 39. 100-Pin EQG Package Dimensions (a) (in Millimeters) 180
Figure 40. 100-Pin EQG Package Dimensions (b) (in Millimeters) 182
Figure 41. EQG100 Recommended Land Pattern with Exposed Pad (in Millimeters) 183

SYNCHRONOUS ETHERNET WAN PLL

IDT82V3380

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FEATURES

HIGHLIGHTS

- The first single PLL chip:
  - Features 0.5 mHz to 560 Hz bandwidth
  - Provides node clock for ITU-T G.8261/G.8262 Synchronous Ethernet
  - 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
  - **FOR REPLACEMENT DEVICE USE IDT82V3380A**

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 $1.1X10^{-5}$ ppm absolute holdover accuracy and $4.4X10^{-8}$ 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 14 input clocks whose frequency cover from 2 kHz to 622.08 MHz
- Provides 9 output clocks whose frequency cover from 1 Hz to 622.08 MHz
- Provides output clocks for BITS, GPS, 3G, GSM, etc.
- Supports AMI, 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
- Synchronous Ethernet 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

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DESCRIPTION

The IDT82V3380 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 frequency 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.

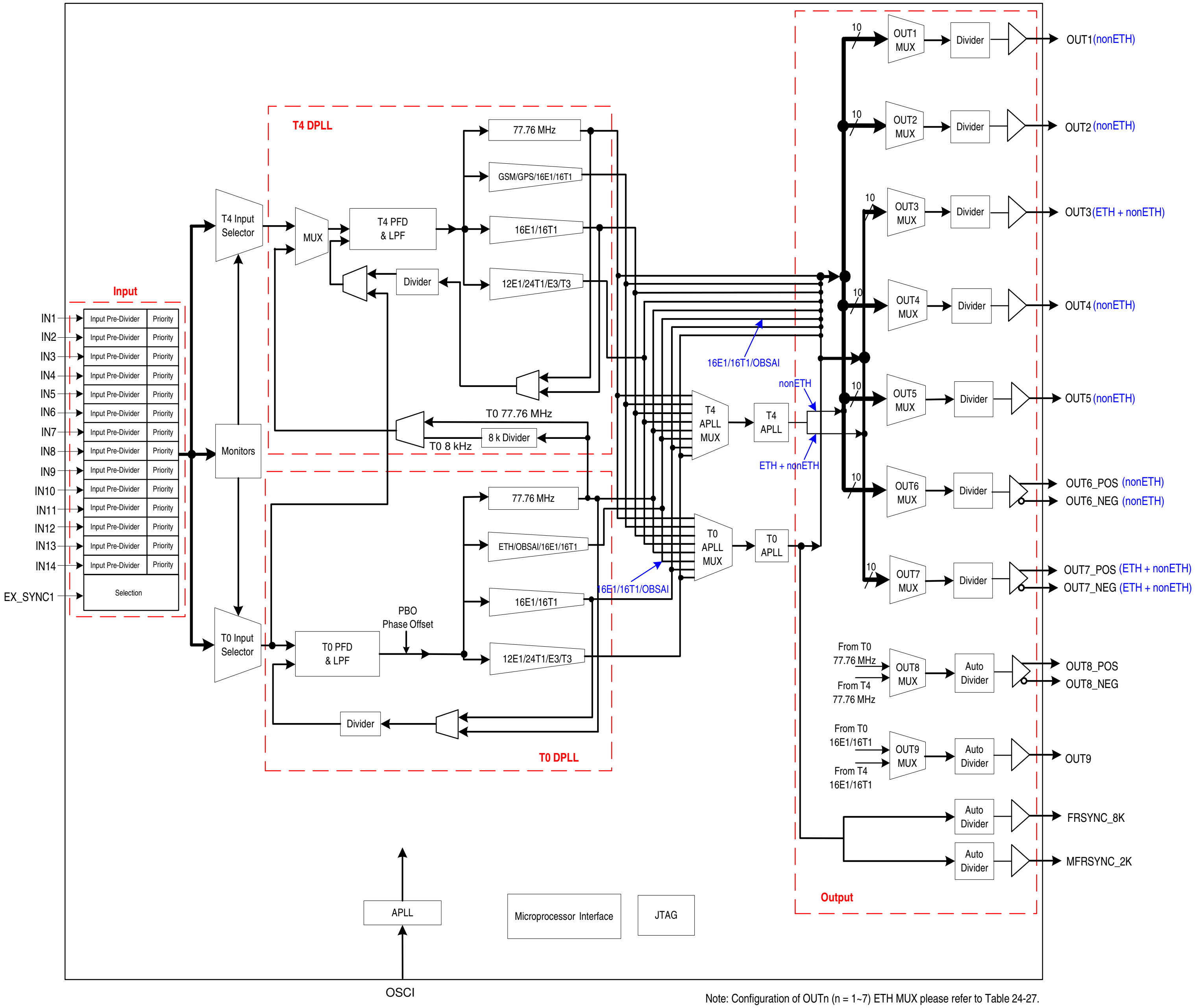
The device provides programmable DPLL bandwidths: 0.5 mHz to 560 Hz in 19 steps and damping factors: 1.2 to 20 in 5 steps. Different settings cover all SONET / SDH clock synchronization requirements.

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


Input
IN1
IN2
IN3
IN4
IN5
IN6
IN7
IN8
IN9
IN10
IN11
IN12
IN13
IN14
EX_SYNC1
Input Pre-Divider
Priority
Selection
T4 Input Selector
Monitors
T0 Input Selector
T4 DPLL
MUX
T4 PFD & LPF
Divider
77.76 MHz
GSM/GPS/16E1/16T1
16E1/16T1
12E1/24T1/E3/T3
T0 77.76 MHz
8 k Divider
T0 8 kHz
T0 DPLL
T0 PFD & LPF
PBO Phase Offset
77.76 MHz
ETH/OBSAI/16E1/16T1
16E1/16T1
12E1/24T1/E3/T3
Divider
T4 APLL MUX
T4 APLL
T0 APLL MUX
T0 APLL
16E1/16T1/OBSAI
nonETH
ETH + nonETH
16E1/16T1/OBSAI
Output
10
OUT1 MUX
OUT2 MUX
OUT3 MUX
OUT4 MUX
OUT5 MUX
OUT6 MUX
OUT7 MUX
Divider
OUT1 (nonETH)
OUT2 (nonETH)
OUT3 (ETH + nonETH)
OUT4 (nonETH)
OUT5 (nonETH)
OUT6_POS (nonETH)
OUT6_NEG (nonETH)
OUT7_POS (ETH + nonETH)
OUT7_NEG (ETH + nonETH)
From T0 77.76 MHz
From T4 77.76 MHz
OUT8 MUX
Auto Divider
OUT8_POS
OUT8_NEG
From T0 16E1/16T1
From T4 16E1/16T1
OUT9 MUX
OUT9
FRSYNC_8K
MFRSYNC_2K
APLL
OSCI
Microprocessor Interface
JTAG

Note: Configuration of OUTn (n = 1~7) ETH MUX please refer to Table 24-27.

Figure 1. Functional Block Diagram

1 PIN ASSIGNMENT

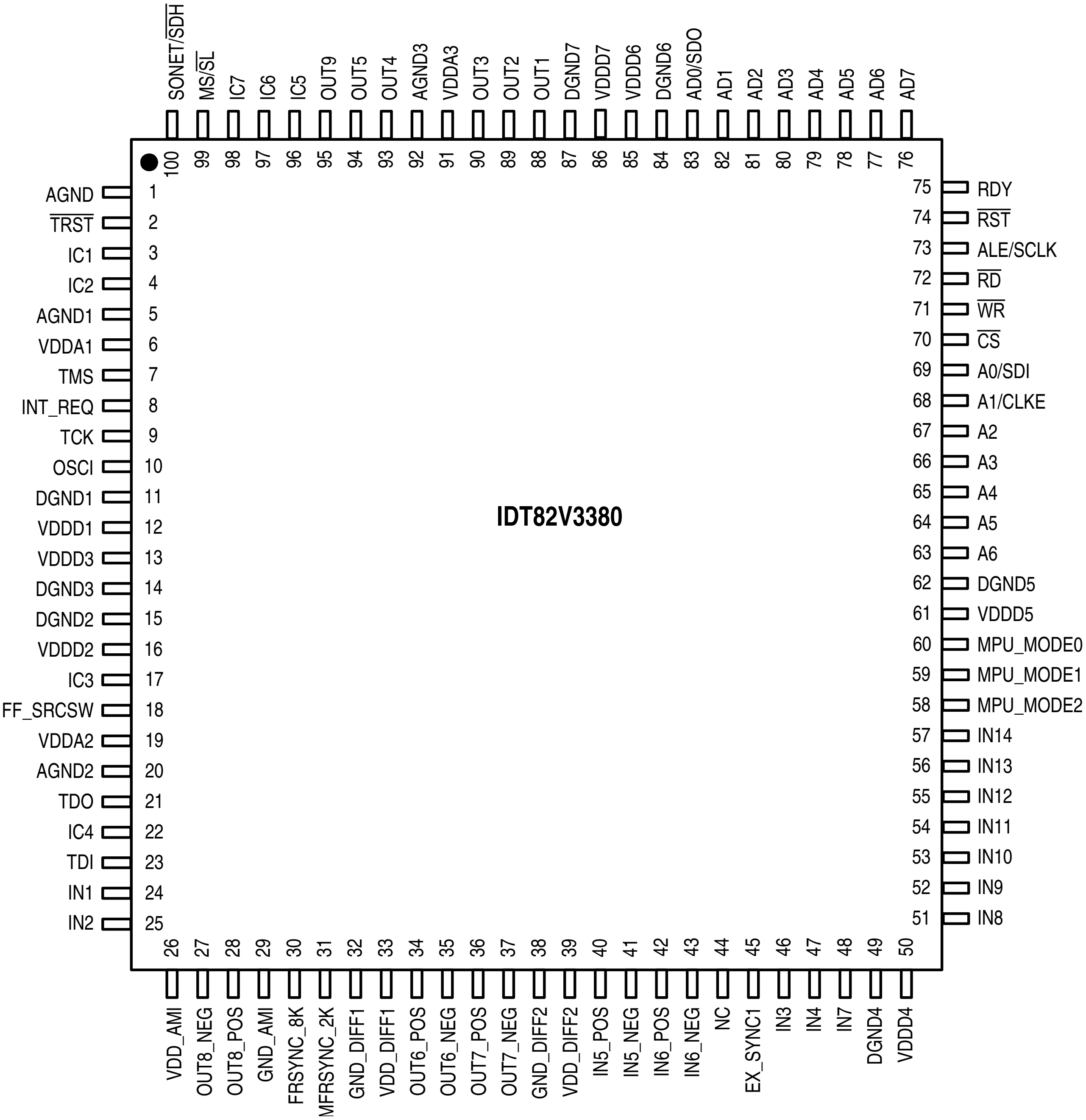

IDT82V3380
100 SONET/$\overline{SDH}$
99 MS/$\overline{SL}$
98 IC7
97 IC6
96 IC5
95 OUT9
94 OUT5
93 OUT4
92 AGND3
91 VDDA3
90 OUT3
89 OUT2
88 OUT1
87 DGND7
86 VDDD7
85 VDDD6
84 DGND6
83 AD0/SDO
82 AD1
81 AD2
80 AD3
79 AD4
78 AD5
77 AD6
76 AD7
1 AGND
2 $\overline{TRST}$
3 IC1
4 IC2
5 AGND1
6 VDDA1
7 TMS
8 INT_REQ
9 TCK
10 OSCI
11 DGND1
12 VDDD1
13 VDDD3
14 DGND3
15 DGND2
16 VDDD2
17 IC3
18 FF_SRCSW
19 VDDA2
20 AGND2
21 TDO
22 IC4
23 TDI
24 IN1
25 IN2
75 RDY
74 $\overline{RST}$
73 ALE/SCLK
72 $\overline{RD}$
71 $\overline{WR}$
70 $\overline{CS}$
69 A0/SDI
68 A1/CLKE
67 A2
66 A3
65 A4
64 A5
63 A6
62 DGND5
61 VDDD5
60 MPU_MODE0
59 MPU_MODE1
58 MPU_MODE2
57 IN14
56 IN13
55 IN12
54 IN11
53 IN10
52 IN9
51 IN8
26 VDD_AMI
27 OUT8_NEG
28 OUT8_POS
29 GND_AMI
30 FRSYNC_8K
31 MFRSYNC_2K
32 GND_DIFF1
33 VDD_DIFF1
34 OUT6_POS
35 OUT6_NEG
36 OUT7_POS
37 OUT7_NEG
38 GND_DIFF2
39 VDD_DIFF2
40 IN5_POS
41 IN5_NEG
42 IN6_POS
43 IN6_NEG
44 NC
45 EX_SYNC1
46 IN3
47 IN4
48 IN7
49 DGND4
50 VDDD4

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_SRCSW	18	I pull-down	CMOS	**FF_SRCSW: 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 IN3 / IN5 is selected. Low: Pair IN4 / IN6 is selected. After reset, the input on this pin takes no effect if the External Fast selection is disabled.
MS/$\overline{\text{SL}}$	99	I pull-up	CMOS	**MS/$\overline{\text{SL}}$: 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/$\overline{\text{SDH}}$	100	I pull-down	CMOS	**SONET/$\overline{\text{SDH}}$: 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.
$\overline{\text{RST}}$	74	I pull-up	CMOS	**$\overline{\text{RST}}$: Reset** A low pulse of at least 50 μs 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	24	I	AMI	**IN1: Input Clock 1** A 64 kHz + 8 kHz or 64 kHz + 8 kHz + 0.4 kHz composite clock is input on this pin.
IN2	25	I	AMI	**IN2: Input Clock 2** A 64 kHz + 8 kHz or 64 kHz + 8 kHz + 0.4 kHz composite clock is input on this pin.
IN3	46	I pull-down	CMOS	**IN3: 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 or 155.52 MHz clock is input on this pin.
IN4	47	I pull-down	CMOS	**IN4: 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 or 155.52 MHz clock is input on this pin.
IN5_POS IN5_NEG	40 41	I	PECL/LVDS	**IN5_POS / IN5_NEG: Positive / Negative 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, 155.52 MHz, 156.25 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.

Table 1: Pin Description (Continued)

Name	Pin No.	I/O	Type	Description [1]
IN6_POS IN6_NEG	42 43	I	PECL/LVDS	**IN6_POS / IN6_NEG: Positive / Negative Input Clock 6** 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, 156.25 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.
IN7	48	I pull-down	CMOS	**IN7: Input Clock 7** 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.
IN8	51	I pull-down	CMOS	**IN8: Input Clock 8** 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.
IN9	52	I pull-down	CMOS	**IN9: Input Clock 9** 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.
IN10	53	I pull-down	CMOS	**IN10: Input Clock 10** 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.
IN11	54	I pull-down	CMOS	**IN11: Input Clock 11** 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 IN11 is recommended to be 6.48 MHz.
IN12	55	I pull-down	CMOS	**IN12: Input Clock 12** 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.
IN13	56	I pull-down	CMOS	**IN13: Input Clock 13** 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.
IN14	57	I pull-down	CMOS	**IN14: Input Clock 14** 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.
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	88	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	89	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	90	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, 25 MHz, E3, T3, 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz, 125 MHz, 155.52 MHz, 156.25 MHz or 312.5 MHz clock is output on this pin.

Table 1: Pin Description (Continued)

Name	Pin No.	I/O	Type	Description [1]
OUT4	93	O	CMOS	**OUT4: 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 or 155.52 MHz clock is output on this pin.
OUT5	94	O	CMOS	**OUT5: 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 or 155.52 MHz clock is output on this pin.
OUT6_POS OUT6_NEG	34 35	O	PECL/LVDS	**OUT6_POS / OUT6_NEG: Positive / Negative Output Clock 6** 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.
OUT7_POS OUT7_NEG	36 37	O	PECL/LVDS	**OUT7_POS / OUT7_NEG: Positive / Negative Output Clock 7** 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, 25 MHz, E3, T3, 6.48 MHz, 19.44 MHz, 25.92 MHz, 38.88 MHz, 51.84 MHz, 77.76 MHz, 125 MHz, 155.52 MHz, 156.25 MHz, 311.04 MHz, 312.5 MHz or 622.08 MHz clock is differentially output on this pair of pins.
OUT8_POS OUT8_NEG	28 27	O	AMI	**OUT8_POS / OUT8_NEG: Positive / Negative Output Clock 8** A 64 kHz + 8 kHz or 64 kHz + 8 kHz + 0.4 kHz composite clock is differentially output on this pair of pins.
OUT9	95	O	CMOS	**OUT9: Output Clock 9** A 1.544 MHz (SONET) / 2.048 MHz (SDH) BITS/SSU clock is output on this pin.
Microprocessor Interface				
$\overline{CS}$	70	I pull-up	CMOS	**$\overline{CS}$: 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).
MPU_MODE0 MPU_MODE1 MPU_MODE2	60 59 58	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).

Table 1: Pin Description (Continued)

Name	Pin No.	I/O	Type	Description [1]
A0 / SDI A1 / CLKE A2 A3 A4 A5 A6	69 68 67 66 65 64 63	I pull-down	CMOS	**A[6:0]: Address Bus** In ERPOM, 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.
AD0 / SDO AD1 AD2 AD3 AD4 AD5 AD6 AD7	83 82 81 80 79 78 77 76	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.
$\overline{WR}$	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 s 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.
ALE / SCLK	73	I pull-down	CMOS	**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. **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. In EPROM, Intel and Motorola modes, this pin should be connected to ground.

Table 1: Pin Description (Continued)

Name	Pin No.	I/O	Type	Description [1]
RDY	75	O	CMOS	**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.
JTAG (per IEEE 1149.1)				
$\overline{\text{TRST}}$	2	I pull-down	CMOS	**$\overline{\text{TRST}}$: 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.
TMS	7	I pull-up	CMOS	**TMS: JTAG Test Mode Select** The signal on this pin controls the JTAG test performance and is sampled on the rising edge of TCK.
TCK	9	I pull-down	CMOS	**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.
TDI	23	I pull-up	CMOS	**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.
TDO	21	O	CMOS	**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.
Power & Ground				
VDDD1 VDDD2 VDDD3 VDDD4 VDDD5 VDDD6 VDDD7	12 16 13 50 61 85 86	Power	-	**VDDDn: 3.3 V Digital Power Supply** Each VDDDn should be paralleled with ground through a 0.1 μF capacitor.
VDDA1 VDDA2 VDDA3	6 19 91	Power	-	**VDDAn: 3.3 V Analog Power Supply** Each VDDAn should be paralleled with ground through a 0.1 μF capacitor.
VDD_AMI	26	Power	-	**VDD_AMI: 3.3 V Power Supply for AMI I/O**
VDD_DIFF1	33	Power	-	**VDD_DIFF1: 3.3 V Power Supply for OUT6**
VDD_DIFF2	39	Power	-	**VDD_DIFF2: 3.3 V Power Supply for OUT7**

Table 1: Pin Description (Continued)

Name	Pin No.	I/O	Type	Description [1]
DGND1 DGND2 DGND3 DGND4 DGND5 DGND6 DGND7	11 15 14 49 62 84 87	Ground	-	**DGNDn: Digital Ground**
AGND1 AGND2 AGND3	5 20 92	Ground	-	**AGNDn: Analog Ground**
GND_DIFF1	32	Ground	-	**GND_DIFF: Ground for OUT6**
GND_DIFF2	38	Ground	-	**GND_DIFF: Ground for OUT7**
GND_AMI	29	Ground	-	**GND_AMI: Ground for AMI I/O**
AGND	1	Ground	-	**AGND: Analog Ground**
Others				
IC1 IC2 IC3 IC4 IC5 IC6 IC7	3 4 17 22 96 97 98	-	-	**IC: Internal Connected** Internal Use. These pins should be left open for normal operation.
NC	44	-	-	**NC: Not Connected**

Note:

1. All the unused input pins should be connected to ground; the output of all the unused output pins are don’t-care.
2. The contents in the brackets indicate the position of the register bit/bits.
3. N x 8 kHz: $1 \leq N \leq 19440$.
4. N x E1: N = 1, 2, 3, 4, 6, 8, 12, 16, 24, 32, 48, 64.
5. N x T1: N = 1, 2, 3, 4, 6, 8, 12, 16, 24, 32, 48, 64, 96.
6. N x 13.0 MHz: N = 1, 2, 4.
7. 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 OSCI 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 OSCI 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 14 clocks and 1 frame sync signal are input to the device.

3.3.1 INPUT CLOCKS

The device provides 14 input clock ports.

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

- AMI
- 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 and IN2 support the AMI input signal only and the clock source is from T3. The input clock is a 64 kHz + 8 kHz or 64 kHz + 8 kHz + 0.4 kHz composite clock. The 400HZ_SEL bit should be set to match the input frequency. Any input violation that does not meet the standard composite clock structure will induce an AMI violation. The AMI violation is indicated by the AMI1_VIOL ^{1} / AMI2_VIOL ^{1} bit. If the AMI1_VIOL ^{2} / AMI2_VIOL ^{2} bit is '1', the occurrence of an AMI violation will trigger an interrupt.

IN3, IN4 and IN7 ~ IN14 support CMOS input signal only and the clock sources can be from T1, T2 or T3.

IN5 and IN6 support PECL/LVDS input signal only 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/$\overline{\text{SDH}}$ pin: high for SONET and low for SDH. After reset, the input signal on the SONET/$\overline{\text{SDH}}$ pin takes no effect.

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)
400HZ_SEL	IN1_CNFG	14
	IN2_CNFG	15
AMI1_VIOL ^{1}	INTERRUPT3_STS	0F
AMI2_VIOL ^{1}		
AMI1_VIOL ^{2}	INTERRUPTS3_ENABLE_CNFG	12
AMI2_VIOL ^{2}		
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 and IN2, the DPLL required frequency is fixed to 8 kHz (i.e., the corresponding IN_FREQ[3:0] bits are ‘0000’). The 8 kHz clock is extracted from the composite clock and the Pre-Divider is bypassed automatically.

For IN3 ~ IN14, 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 IN5 and IN6), a DivN Divider and a Lock 8k Divider, as shown in Figure 3.

The HF Divider, which is only available for IN5 and IN6, 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 IN5_DIV[1:0]/IN6_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 ($3 \le n \le 14$), 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:

Division Factor = (the frequency of the clock input to the DivN Divider ÷ 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 IN3 ~ IN14 pins and the DPLL required clock. Here is an example:

The input clock on the IN6 pin is 622.08 MHz; the DPLL required clock is 6.48 MHz by programming the IN_FREQ[3:0] bits of register IN6 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 IN6_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 IN6_CNFG to ‘1’ and the LOCK_8K bit in Register IN6_CNFG to ‘0’;
   155.52 ÷ 6.48 = 24; 24 - 1 = 23, so set the PRE_DIVN_VALUE[14:0] bits to ‘10111’.

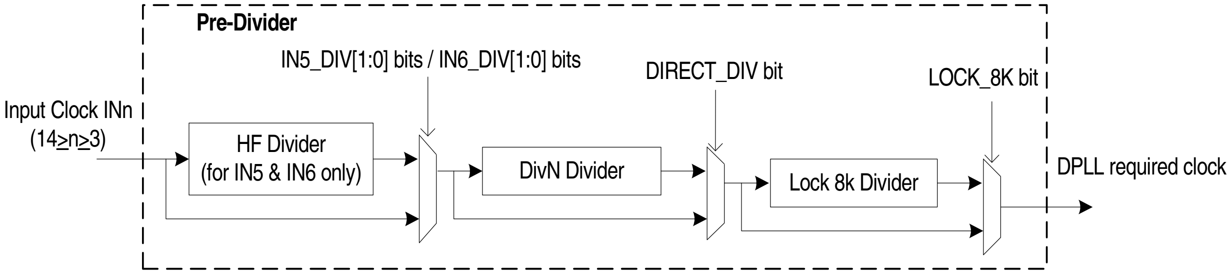


Figure 3. Pre-Divider for An Input Clock

Table 4: Related Bit / Register in Chapter 3.4

Bit	Register	Address (Hex)
IN5_DIV[1:0]	IN5_IN6_HF_DIV_CNFG	18
IN6_DIV[1:0]		
IN_FREQ[3:0]	IN1_CNFG ~ IN14_CNFG	14 ~ 17, 19 ~ 22
IN_2K_4K_8K_INV	FR_MFR_SYNC_CNFG	74
DIRECT_DIV	IN3_CNFG ~ IN14_CNFG	16, 17, 19 ~ 22
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:

- LOS (loss of signal) (only for IN1 and IN2)
- Activity
- Frequency

LOS monitoring is only conducted on IN1 and IN2. 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 LOS MONITORING

IN1 and IN2 support the AMI input signal. LOS monitoring is conducted on IN1 and IN2. A LOS event occurs when the amplitude of the input clock falls below +0.6 Vp-p for 1 ms; the LOS event is cleared when the amplitude rises higher than +1 Vp-p.

LOS status is indicated by the AMI1_LOS [1] / AMI2_LOS [1] bit. If the AMI1_LOS [2] / AMI2_LOS [2] bit is '1', the occurrence of LOS will trigger an interrupt.

The input clock in LOS status is disqualified for clock selection for T0/T4 DPLL.

3.5.2 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 reach 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 0 ~ 3.

The no-activity alarm status of the input clock is indicated by the INn_NO_ACTIVITY_ALARM bit (14 ≥ n ≥ 1).

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

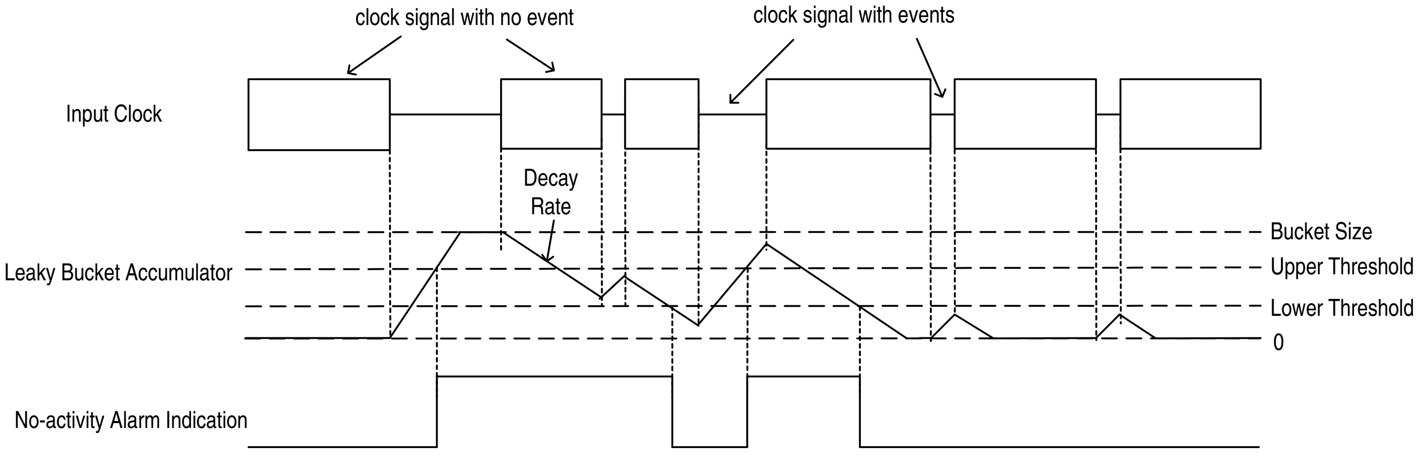


Figure 4. Input Clock Activity Monitoring

3.5.3 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:

Frequency Hard Alarm Threshold (ppm) = (ALL_FREQ_HARD_THRESHOLD[3:0] + 1) X 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 (14 ≥ n ≥ 1). 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 ±5%, the input clock is disqualified for clock selection for T0/T4 DPLL. The input clock is qualified if any edge drifts inside ±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:*

   Input Clock Frequency (ppm) = IN_FREQ_VALUE[7:0] X 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)
AMI1_LOS ^{1}	INTERRUPTS3_STS	0F
AMI2_LOS ^{1}		
AMI1_LOS ^{2}	INTERRUPTS3_ENABLE_CNFG	12
AMI2_LOS ^{2}		
BUCKET_SIZE_n_DATA[7:0] (3 ≥ n ≥ 0)	BUCKET_SIZE_0_CNFG ~ BUCKET_SIZE_3_CNFG	33, 37, 3B, 3F
UPPER_THRESHOLD_n_DATA[7:0] (3 ≥ n ≥ 0)	UPPER_THRESHOLD_0_CNFG ~ UPPER_THRESHOLD_3_CNFG	31, 35, 39, 3D
LOWER_THRESHOLD_n_DATA[7:0] (3 ≥ n ≥ 0)	LOWER_THRESHOLD_0_CNFG ~ LOWER_THRESHOLD_3_CNFG	32, 36, 3A, 3E
DECAY_RATE_n_DATA[1:0] (3 ≥ n ≥ 0)	DECAY_RATE_0_CNFG ~ DECAY_RATE_3_CNFG	34, 38, 3C, 40
BUCKET_SEL[1:0]	IN1_CNFG ~ IN14_CNFG	14 ~ 17, 19 ~ 22
INn_NO_ACTIVITY_ALARM (14 ≥ n ≥ 1)	IN1_IN2_STS ~ IN13_IN14_STS	43 ~ 49
INn_FREQ_HARD_ALARM (14 ≥ n ≥ 1)		
FREQ_MON_CLK	MON_SW_PBO_CNFG	0B
FREQ_MON_HARD_EN		
ALL_FREQ_HARD_THRESHOLD[3:0]	ALL_FREQ_MON_THRESHOLD_CNFG	2F
FREQ_MON_FACTOR[3:0]	FREQ_MON_FACTOR_CNFG	2E
IN_NOISE_WINDOW	PHASE_MON_PBO_CNFG	78
IN_FREQ_READ_CH[3:0]	IN_FREQ_READ_CH_CNFG	41
IN_FREQ_VALUE[7:0]	IN_FREQ_READ_STS	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 IN3/IN5 and IN4/IN6 pairs.

Forced selection is done by setting the related registers.

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 IN3/IN5 and IN4/IN6 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 IN3_SEL_PRIORITY[3:0] bits and the IN4_SEL_PRIORITY[3:0] bits, as shown in Figure 5 and Table 8:

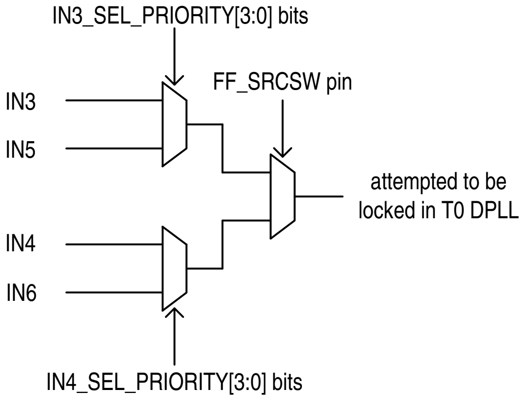

IN3_SEL_PRIORITY[3:0] bits
FF_SRCSW pin
IN3
IN5
IN4
IN6
attempted to be locked in T0 DPLL
IN4_SEL_PRIORITY[3:0] bits

Figure 5. External Fast Selection

Table 8: External Fast Selection

Control Pin & Bits			the Selected Input Clock
FF_SRCSW (after reset)	IN3_SEL_PRIORITY[3:0]	IN4_SEL_PRIORITY[3:0]	
high	0000	don't-care	IN5
	other than 0000		IN3
low	don't-care	0000	IN6
		other than 0000	IN4