*Advanced Science And Novel Technology Company, Inc.*
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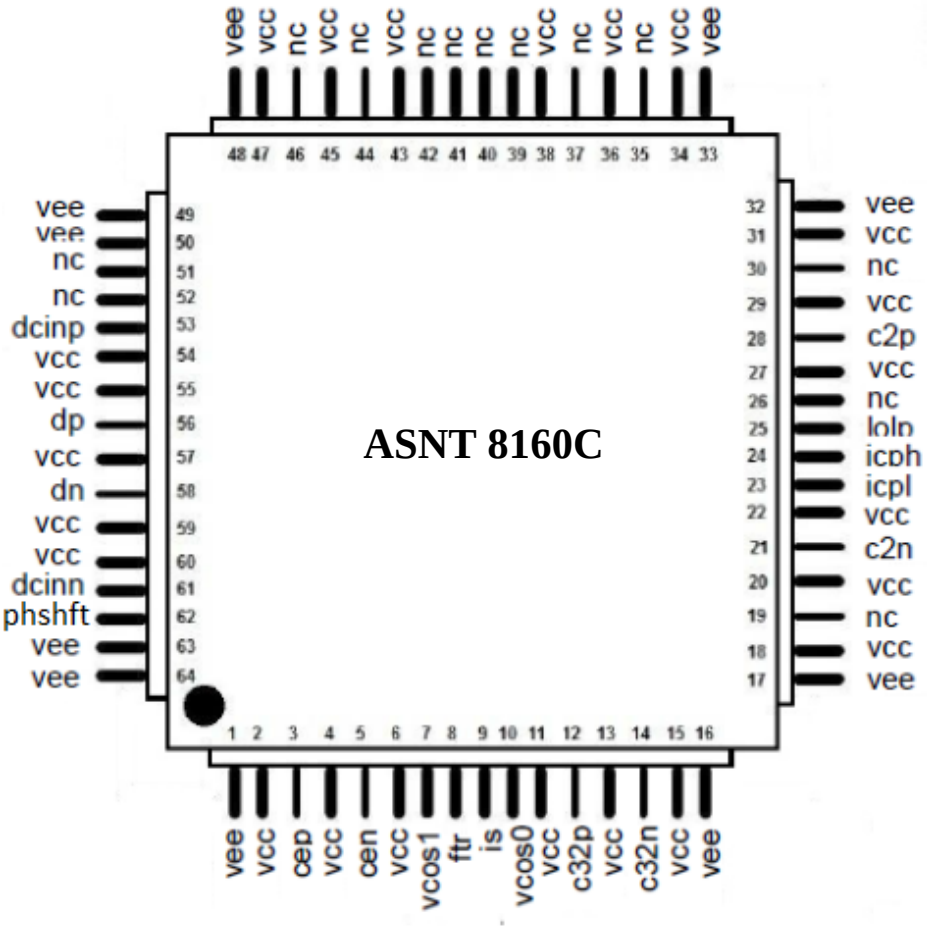
# ASNT8160C-KMF
# Programmable CR

- Up to 65*Gb/s* half-rate clock recovery circuit
- CR range from 24.5*GHz* to 32.0*GHz* covered by 3 selectable VCOs
- NRZ input data format
- CML compliant differential input and output high-speed data and clock interfaces
- LVDS compliant input reference clock interface
- Half rate clock output up to 32*GHz* for a 64*Gb/s* input data signal
- Single +3.3*V* or -3.3*V* power supply
- Low power consumption of 1.6*W* at the maximum operational speed
- Industrial temperature range
- Custom CQFP 64-pin package



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# DESCRIPTION

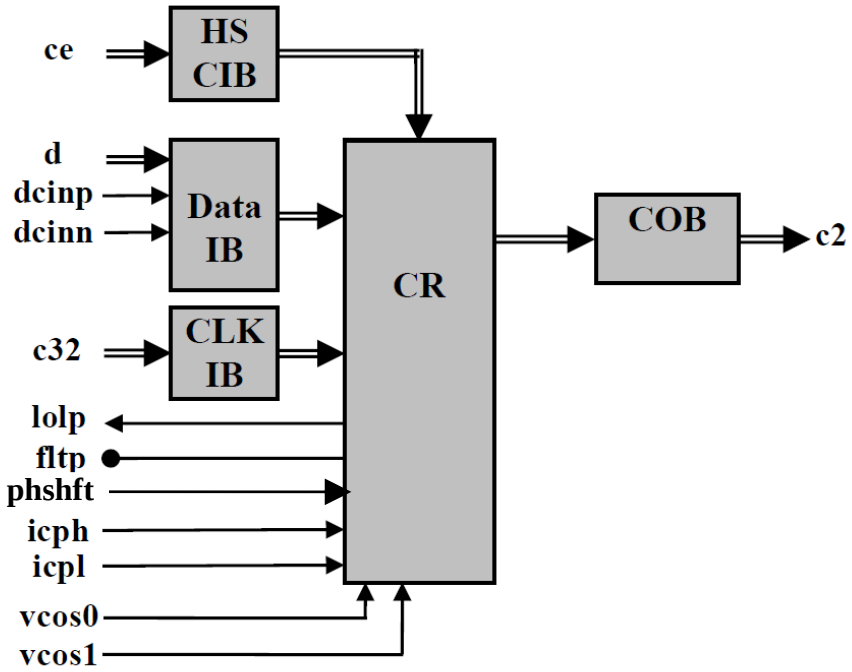


*Fig. 1. Functional Block Diagram*

ASNT8160C-KMF is a half-rate integrated clock recovery (CR) circuit. The IC shown in Fig. 1 functions in the CR mode covering a wide range of input data rates ($f_{bit}$) by utilizing its three on-chip VCOs (voltage-controlled oscillators). Selection of the desired working data rate and mode is accomplished through pins vcos0 and vcos1 (see Table 1). An external low speed system clock c32p/c32n running at 1/32 the frequency of the active VCO must be applied to the low-speed LVDS clock input buffer (CLK IB) for the IC to work properly.

The main function of the chip is to recover from an NRZ input data signal dp/dn with a bit rate of $f_{bit}$ accepted by CML buffer (Data IB) a half-rate clock c2p/c2n that is delivered to the output by the CML clock output buffer (COB). For example, a 30*GHz* clock signal will be generated from a 60*Gb/s* input data signal. The signal phshft is used to properly set the phase of the internal clock.

Data IB can operate with either differential or single-ended input signals. It includes tuning pins dcinp/dcinn for DC offset of the input signals in case of AC termination. When the buffer is operating with a DC-terminated single ended input signal, a correct threshold voltage should be applied to the unused input pin.

All CML I/Os provide on chip 50*Ohm* termination to vcc and may be used differentially, AC/DC coupled, single-ended, or in any combination (see also POWER SUPPLY CONFIGURATION).

A loss of lock CMOS alarm signal lolp is generated by the CR to indicate its locking state. An off chip passive filter is required by the CR, and should be connected to pin ftr (see CR section).

The clock recovery circuit is characterized for operation from 0°*C* to 125°*C* of junction temperature. The package temperature resistance is 15°*C* /*W*.

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## Data IB

The Data Input Buffer (Data IB) can process an input CML data signal dp/dn in NRZ format. It provides on-chip single-ended termination of 50*Ohm* to vcc for each input line. The buffer can also accept a single-ended signal to one of its input ports dp or dn with a threshold voltage applied to the unused pin in case of DC termination. In case of AC termination, tuning pins dcinp/dcinn allow for data common mode adjustment. The tuning pins have 1*KOhm* terminations to vcc and allow the user to change the slicing level before the data is sent to the clock recovery section. Tuning voltages from vcc to vee deliver 150*mV* of DC voltage shift.

## HS CIB

The High-Speed Clock Input Buffer (HS CIB) can process either differential or single-ended external CML clock signals cep/cen. In single-ended mode, the clock is applied to one of the pins together with a threshold voltage applied to the unused pin. The buffer utilizes on-chip single-ended termination of 50*Ohm* to vcc for each input line. This functionality is for test purposes only.

## CLK IB

The Clock Input Buffer (CLK IB) consists of a proprietary universal input buffer (UIB) that exceeds LVDS standards IEEE Std. 1596.3-1996 and ANSI/TIA/EIA-644-1995. UIB is designed to accept differential signals with a speed up to 1*Gb/s*, DC common mode voltage variation between vcc and vee, AC common mode noise with a frequency up to 5*MHz*, and voltage levels ranging from 0 to 2.4*V*. It can also receive a DC-terminated single-ended signal with a threshold voltage between vcc and vee applied to the unused pin. The input termination impedance is set to 100*Ohm* differential.

## CR

The Clock Recovery Block (CR) contains both a phase and frequency acquisition loop. The frequency loop works in concert with low-speed clock c32p/c32n while the phase loop utilizes data signal dp/dn. The CR requires a single off-chip filter shown in Fig. 2 to be connected to pin ftr.

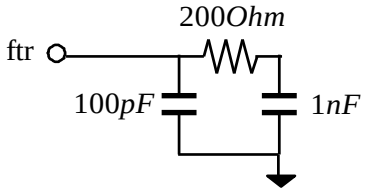


*Fig. 2. External Loop Filter*

The main function of the CR is to frequency-lock the selected on-chip VCO to the input data signal (clock recovery). Using the external control voltage phshft within the range from vcc to vcc-1.0V, the phase of the internal half rate clock needs to be lined up correctly with the incoming data in the phase loop to ensure proper CR functionality.

By utilizing the 2.5*V* CMOS control pins vcos0 and vcos1, the desired working frequency of the CR can be selected in accordance with Table 1 below.

*Table 1. CR Mode Selection (Case Temperature from 0 to 90°C)*

| vcos0 | vcos1 | VCO Operation Frequency (*GHz*) |
|---|---|---|
| "0" (0*V*) | "0" (0*V*) | $f_{min}$≤24.5, $f_{max}$≥28.0 |
| "0" (0*V*) | "1" (2.5*V*) | $f_{min}$≤27.5, $f_{max}$≥29.5 |
| "1" (2.5*V*) | "0" (0*V*) | $f_{min}$≤29.0, $f_{max}$≥32.0 |
| "1" (2.5*V*) | "1" (2.5*V*) | Digital Mode, default state |

The loop gain can be adjusted by two 2.5*V* CMOS control pins icph and icpl that control the charge pump current as shown in Table 2.

*Table 2. Charge Pump Current Control*

| icph | icpl | Charge Pump current, *mA* |
|---|---|---|
| "0" (0*V*) | "0" (0*V*) | *I*max |
| "0" (0*V*) | "1" (2.5*V*) | *I*max-0.04 |
| "1" (2.5*V*) | "0" (0*V*) | *I*max-0.27 |
| "1" (2.5*V*) | "1" (2.5*V*) | *I*max-0.31 |

## LOL

The lock detect circuitry generates at its lolp output constant low and high voltage levels or low-speed pulses between those levels. The high level indicates that a frequency difference exists between an applied system reference clock c32p/c32n and a recovered half rate clock divided-by-32 that is greater than ±1000*ppm*. The low level or pulses indicate the lock state of CR.

The pulses may be converted into a constant voltage below 2*V* using a 1*MHz* low-pass filter. In this case, a voltage above 2.1*V* indicates loss of lock and a voltage below 2*V* indicates the lock state.

## COB

The Clock Output Buffer (COB) receives a half rate clock signal from CR and converts it into CML output signal c2p/c2n. The buffer requires 50*Ohm* external termination resistors connected between vcc and each output (usually supplied by the downstream chip that the buffer is driving).

## POWER SUPPLY CONFIGURATION

The ASNT8160C-KMF can operate with either a negative supply (vcc = 0.0*V* = ground and vee = -3.3*V*), or a positive supply (vcc = +3.3*V* and vee = 0.0*V* = ground). In case of a positive supply, all I/Os need AC termination when connected to any devices with 50*Ohm* termination to ground. Different PCB layouts will be needed for each different power supply combination.

### All the characteristics detailed below assume vcc = 3.3*V* and vee = 0*V* (external ground)

## ABSOLUTE MAXIMUM RATINGS

Caution: Exceeding the absolute maximum ratings shown in Table 3 may cause damage to this product and/or lead to reduced reliability. Functional performance is specified over the recommended operating conditions for power supply and temperature only. AC and DC device characteristics at or beyond the

absolute maximum ratings are not assumed or implied. All min and max voltage limits are referenced to ground (assumed vee).

*Table 3. Absolute Maximum Ratings*

| Parameter | Min | Max | Units |
|---|---|---|---|
| Supply Voltage (vcc) | | +3.8 | *V* |
| Power Consumption | | 1.6 | *W* |
| Input Voltage Swing (SE) | | 1.0 | *V* |
| Case Temperature*) | | +90 | *°C* |
| Storage Temperature | -40 | +100 | *°C* |
| Operational Humidity | 10 | 98 | *%* |
| Storage Humidity | 10 | 98 | *%* |

# TERMINAL FUNCTIONS

| TERMINAL | | | DESCRIPTION |
|---|---|---|---|
| **Name** | **No.** | **Type** | |
| **High-Speed I/Os** | | | |
| cep | 3 | Input | CML differential half rate clock inputs with internal SE 50*Ohm* termination to vcc |
| cen | 5 | | |
| c2p | 28 | Output | CML differential half rate clock outputs. Require external SE 50*Ohm* termination to vcc |
| c2n | 21 | | |
| dp | 56 | Input | CML differential data inputs with internal SE 50*Ohm* termination to vcc |
| dn | 58 | | |
| **Low-Speed I/Os** | | | |
| c32p | 12 | Input | LVDS clock input with internal differential 100*Ohm* termination |
| c32n | 14 | | |
| **Controls** | | | |
| vcos1 | 7 | LS In., 2.5*V* CMOS | CR operational mode selection, see Table 1 |
| vcos0 | 10 | | |
| is | 9 | | VCO current control (high, default: higher current; low: lower current) |
| icpl | 23 | | Charge pump current control, see Table 2 |
| icph | 24 | | |
| lolp | 25 | LS out, 2.5*V* | CR lock indicator (above 2.1*V*: no lock; below 2.0*V*: locked; low-speed pulses: locked) |
| dcinp | 53 | LS IN | Input data common mode voltage adjustment |
| dcinn | 61 | | |
| phshft | 62 | DC Input | CR clock phase adjustment. Allowed values from vcc to vcc-1.0V |
| ftr | 8 | I/O | External CR filter connection |

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| Supply and Termination Voltages | | |
|---|---|---|
| **Name** | **Description** | **Pin Number** |
| vcc | Positive power supply (+3.3*V*) | 2, 4, 6, 11, 13, 15, 18, 20, 22, 27, 29, 31, 34, 36, 38, 43, 45, 47, 54, 55, 57, 59, 60 |
| vee | Negative power supply (GND or 0*V*) | 1, 16, 17, 32, 33, 48, 49, 50, 63, 64 |
| nc | Not connected pins | 19, 26, 30, 35, 37, 39, 40, 41, 42, 44, 46, 51, 52 |

# ELECTRICAL CHARACTERISTICS

| PARAMETER | MIN | TYP | MAX | UNIT | COMMENTS |
|---|---|---|---|---|---|
| **General Parameters** | | | | | |
| vcc | +3.0 | +3.3 | +3.6 | *V* | ±9% |
| vee | | 0.0 | | *V* | |
| $I_{vcc}$ | | 490 | | *mA* | All functions active |
| Power Consumption | | 1.6 | | *W* | |
| Junction Temperature | -25 | 50 | 125 | *°C* | |
| Case temperature | | | 75 | *°C* | Recommended value |
| **HS Input Data (dp/dn)** | | | | | |
| Data Rate | 49 | | 64 | *Gbps* | RZ or NRZ |
| Swing p-p (Diff or SE) | 0.3 | | 0.6 | *V* | at 64*Gbps* |
| CM Voltage Level | vcc-0.8 | | vcc | *V* | |
| **LS Input Reference Clock (c32p/c32n)** | | | | | |
| Frequency | 765.7 | | 1000 | *MHz* | |
| Swing p-p (Diff or SE) | 0.06 | | 0.8 | *V* | |
| CM Voltage Level | vee | | vcc | *V* | |
| Duty Cycle | 40 | 50 | 60 | *%* | |
| **HS Output Half Rate Clock (c2p/c2n)** | | | | | |
| Clock Rate | 24.5 | | 32.0 | *GHz* | 50 to 64*Gbps* input |
| Logic “1” level | | vcc | | *V* | |
| Logic “0” level | vcc -0.4 | | vcc -0.15 | *V* | |
| Jitter | | 5 | 8 | *ps* | p-p at 25.6*GHz* |
| **Input Data Common Mode Control (dcinp/dcinn)** | | | | | |
| Input DC Voltage | vee | | vcc | *V* | |
| Input Data Voltage Shift | 0 | | -150 | *mV* | Referenced to vcc |
| **CMOS Control Inputs/Outputs** | | | | | |
| Logic “1” level | 2.1 | | 2.5 | *V* | |
| Logic “0” level | | | vee +0.4 | *V* | |
| **Data Sampling Point Adjustment (phshft)** | | | | | |
| Internal termination | | 1.8 | | *kOhm* | SE to vcc |
| Input DC Voltage | vcc -1.0 | | vcc | *V* | |
| Bandwidth | 0.0 | | 100 | *MHz* | |

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# PACKAGE INFORMATION

The chip die is housed in a custom 64-pin CQFP package. The dimensioned drawings are shown in Fig. 3. The package provides a center heat slug located on its back side to be used for heat dissipation. ADSANTEC recommends for this section to be soldered to the VCC plain, which is ground for a negative supply, or power for a positive supply.

The part's identification label is ASNT8160C-KMF. The first 9 characters of the name before the dash identify the bare die including general circuit family, fabrication technology, specific circuit type, and part version while the 3 characters after the dash represent the package's manufacturer, type, and pin out count.

This device complies with the Restriction of Hazardous Substances (RoHS) per 2011/65/EU for all ten substances.

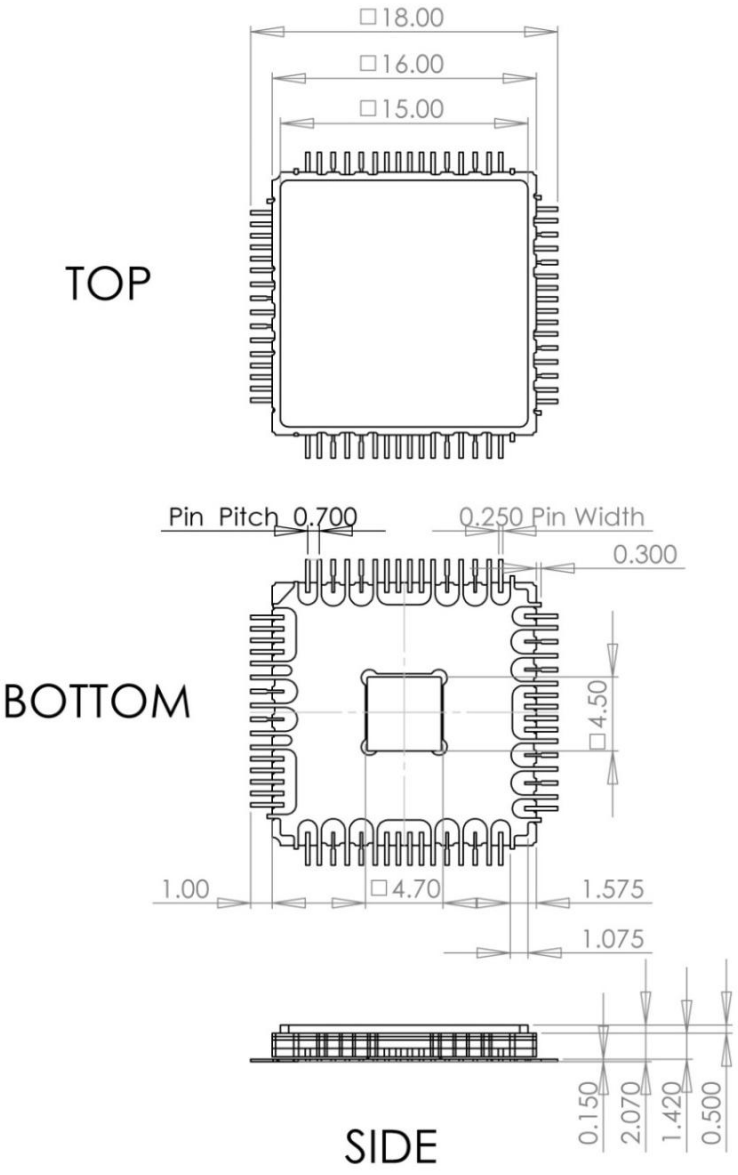


*Fig. 3. CQFP 64-Pin Package Drawing (All Dimensions in mm)*

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# REVISION HISTORY

| Revision | Date | Changes |
|---|---|---|
| 1.2.2 | 10-2020 | Updated the higher frequency of operation |
| 1.1.2 | 10-2020 | Updated the lower frequency of operation |
| 1.0.2 | 09-2020 | Preliminary release |