

# Agilent HDMP-0482 Octal Cell Port Bypass Circuit with CDR and Data Valid Detection Data Sheet

## Description

The HDMP-0482 is an Octal Cell Port Bypass Circuit (PBC) with Clock and Data Recovery (CDR) and data valid detection capability included. This device minimizes part count, cost and jitter accumulation while repeating incoming signals. Port Bypass Circuits are used in hard disk arrays constructed in Fibre Channel Arbitrated Loop (FC-AL) configurations. By using Port Bypass Circuits, hard disks may be pulled out or swapped while other disks in the array are available to the system.

A Port Bypass Circuit (PBC) consists of multiple 2:1 multiplexers daisy chained along with a CDR. Each port has two modes of operation: “disk in loop” and “disk bypassed”. When the “disk in loop” mode is selected, the loop goes into and out of the disk drive at that port. For example, data goes from the HDMP-0482’s TO\_NODE[n]± differential output pins to the Disk Drive Transceiver IC’s (e.g. an HDMP-1636A) Rx± differential input pins. Data from the Disk Drive Transceiver IC’s Tx± differential outputs goes to

the HDMP-0482’s FM\_NODE[n]± differential input pins. When the “disk bypassed” mode is selected, the disk drive is either absent or non-functional and the loop bypasses the hard disk.

The “disk bypassed” mode is enabled by pulling the BYPASS[n]- pin low. Leave BYPASS[n]- floating to enable the “disk in loop” mode. HDMP-0482’s may be cascaded with other members of the HDMP-04XX/HDMP-05XX family through the FM\_NODE and TO\_NODE pins to accommodate any number of hard disks. The unused cells in this PBC may be bypassed by using pulldown resistors on the BYPASS[n]- pins for these cells.

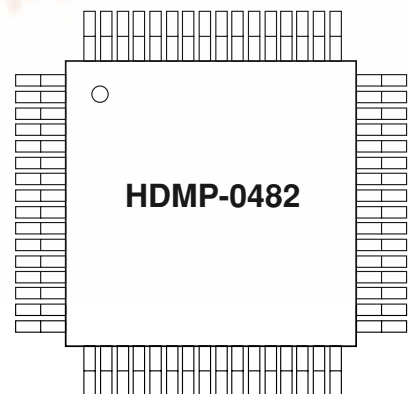
An HDMP-0482 may also be used as eight 1:1 buffers, one with a CDR and seven without. For example, an HDMP-0482 may be placed in front of a CMOS ASIC to clean the jitter of the outgoing signal (CDR path) and to better read the incoming signal (non-CDR path). In addition, the HDMP-0482 may be configured as four 2:1 multiplexers or as four 1:2 buffers.

## Features

- Supports 1.0625 Gb/s fibre channel operation
- Supports 1.25 Gb/s Gigabit Ethernet (GE) operation
- Octal cell PBC/CDR in one package
- CDR location determined by choice of cable input/output
- Amplitude valid detection on FM\_NODE[7] input
- Data valid detection on FM\_NODE[0] input
  - Run length violation detection
  - Comma detection
  - Configurable for both single-frame and multi-frame detection
- Equalizers on all inputs
- High speed LVPECL I/O
- Buffered Line Logic (BLL) outputs (no external bias resistors required)
- 1.09 W typical power at Vcc = 3.3V
- 64 Pin, 14 mm, low cost plastic QFP package

## Applications

- RAID, JBOD, BTS cabinets
- Four 2:1 muxes
- Four 1:2 buffers
- 1 = > N gigabit serial buffer
- N = > 1 gigabit serial mux



CAUTION: As with all semiconductor ICs, it is advised that normal static precautions be taken in the handling and assembly of this component to prevent damage and/or degradation which may be induced by electrostatic discharge (ESD).



The HDMP-0482 design allows for CDR placement at any location with respect to the hard disk slots. For example, if the BYPASS[0]- pin is floating and hard disk slots A to G are connected to PBC cells 1 to 7, respectively, the CDR function will be performed

before entering the hard disk at slot A. To obtain a CDR function after slot G, BYPASS[1]- must be floating and hard disk slots A to G must be connected to PBC cells 2,3,4,5,6,7 and 0, respectively. Table 1 shows all possible connections.

For configurations where the CDR is before slot A, a Data Valid (FM\_NODE[0]\_DV) pin indicates whether the incoming data on FM\_NODE[0]± is valid Fibre Channel data. In addition, an Amplitude Valid (FM\_NODE[7]\_AV) pin shows the status of the signal at FM\_NODE[7].

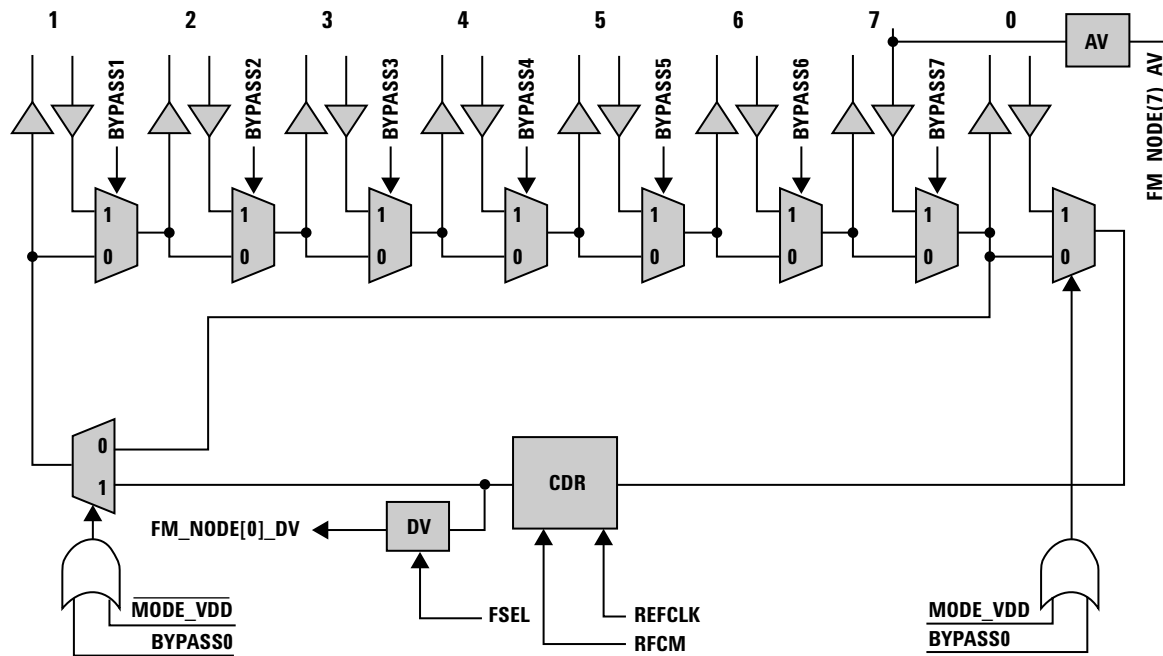


Figure 1. Block Diagram of HDMP-0482.

## HDMP-0482 Block Diagram

### CDR

The Clock and Data Recovery (CDR) block is responsible for frequency and phase locking onto the incoming serial data stream and resampling the incoming data based on the recovered clock. An automatic locking feature allows the CDR to lock onto the input data stream without external training controls. It does this by continually frequency locking onto the 106.25 MHz reference clock (REFCLK) and then phase locking onto the input data stream. Once bit locked, the CDR generates a high-speed sampling clock. This clock is used to

sample or repeat the incoming data to produce the CDR output. The CDR jitter specifications listed in this data sheet assume an input that has been 8B/10B encoded.

### DV Output

The Data Valid (DV) block detects if the incoming data on FM\_NODE[0]± is valid Fibre Channel data. The DV checks for sufficient K28.5+ characters (per Fibre Channel framing rules) and for run length violations (per 8B/10B encoding) on the data coming out of the CDR. The FM\_NODE[0]\_DV output is pulled low if a run length viola-

tion (RLV) occurs, or if there are no commas detected (NCD) in a sufficient time. It is pulled high if no errors are found. A RLV error is defined as any consecutive sequence of 1s or 0s greater than five in the serial data bit stream. A NCD error indicates the absence of a seven-bit pattern (0011111) present in the positive disparity comma (K28.5+) character. A K28.5+ character should occur at the beginning of every Fibre Channel frame of 2148 bytes (or 21480 serial bits), as well as many times within and between frames. If this seven-bit pattern is not found within a  $2^{15}$  bit (~31  $\mu$ s) interval, an NCD error is generated.

When the DV is configured in single-frame mode (FSEL low), any RLV and NCD errors stored during this  $2^{15}$  bit interval cause FM\_NODE[0]\_DV to be pulled low on the next subsequent interval. FM\_NODE[0]\_DV remains low until after an entire  $2^{15}$  bit interval in which no RLVs occur and at least one comma is detected. At that time, FM\_NODE[0]\_DV is pulled high. A multi-frame mode (FSEL high) configuration of the DV is also available. When in multi-frame mode, the FM\_NODE[0]\_DV output is only pulled low when four consecutive  $2^{15}$  bit intervals of bad data have been transmitted. Once low, FM\_NODE[0]\_DV does not go high again until four consecutive  $2^{15}$  bit intervals of good data are transmitted.

#### **AV Output**

The Amplitude Valid (AV) block detects if the incoming data on FM\_NODE[7] $\pm$  is valid by examining the differential amplitude of that input. The incoming data is considered valid, and FM\_NODE[7]\_AV is driven high, as long as the amplitude is greater than 400 mV (differential peak-to-peak). FM\_NODE[7]\_AV is driven low as long as the amplitude of the input signal is less than 100 mV (differential peak-to-peak). When the amplitude of the input signal is between 100–400 mV (differential peak-to-peak), FM\_NODE[7]\_AV is unpredictable. The FM\_NODE[7]\_AV output is latched in with an internally generated  $2^{15}$  bit clock. Similar to the DV function, the AV can be configured for single-frame or multi-frame operation.

#### **BLL Output**

All TO\_NODE[n] $\pm$  high-speed differential outputs are driven by a Buffered Line Logic (BLL) circuit that has on-chip source termination, so no external bias resistors are required. The BLL Outputs on the HDMP-0482 are of equal strength and can drive in excess of 120 inches of FR-4 PCB trace. Unused outputs should not be left unconnected. Ideally, unused outputs should have their differential pins shorted together with a short PCB trace. If transmission lines are connected to the output pins, the lines should be differentially terminated with an appropriate resistor. The value of the termination resistor should match the PCB trace differential impedance.

#### **EQU Input**

All FM\_NODE[n] $\pm$  high-speed differential inputs have an Equalization (EQU) buffer to offset the effects of skin loss and dispersion on PCBs. An external termination resistor is required across all high-speed inputs.

#### **BYPASS[N]- Input**

The active low BYPASS[n]- inputs control the data flow through the HDMP-0482. All BYPASS pins are LVTTTL and contain internal pull-up circuitry. To bypass a port, the appropriate BYPASS[n]- pin should be connected to GND through a 1k $\Omega$  resistor. Otherwise, the BYPASS[n]- inputs should be left to float. In this case, the internal pull-up circuitry will force them high.

#### **REFCLK Input**

The LVTTTL REFCLK input provides a reference oscillator for frequency acquisition of the CDR. The REFCLK frequency should be within  $\pm 100$  ppm of one-tenth or one-twentieth of the incoming data rate in baud (106.25 MHz  $\pm 100$  ppm, or 53.125 MHz  $\pm 100$  ppm for FC-AL running at 1.0625 GBd).

#### **RFCM Input**

The LVTTTL RFCM input configures the CDR to accept a REFCLK at either one-tenth or one-twentieth of the incoming data rate in baud. The RFCM input has internal pull-up circuitry, so the user should connect the pin to GND through a 1k $\Omega$  resistor for a REFCLK at one-twentieth the incoming data rate. For a REFCLK at one-tenth the incoming data rate, let RFCM float high.

#### **MODE\_VDD Input**

The active high valid data detect mode pin selects data checking of the FM\_NODE [0] +/- inputs. When high, MODE\_VDD overrides BYPASS [0] and forces the incoming data into the CDR for error checking. When low, the chip can be configured for CDR anywhere capability. Refer to Figures 2 & 3 for high and low MODE\_VDD configuration.

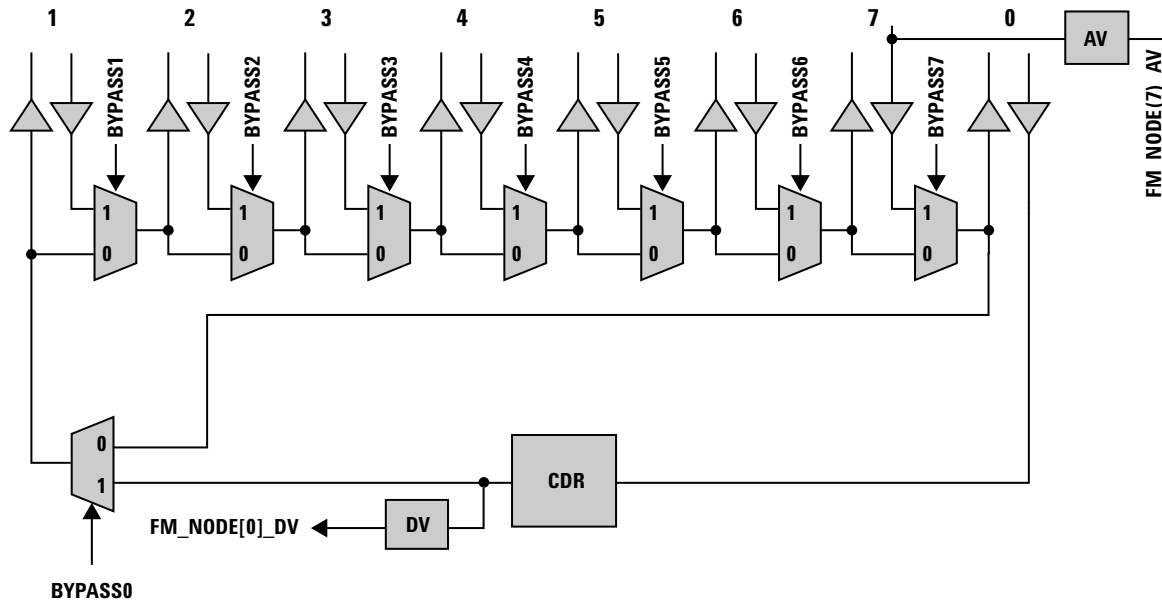


Figure 2. Block Diagram of HDMP-0482, MODE\_VDD is HIGH.

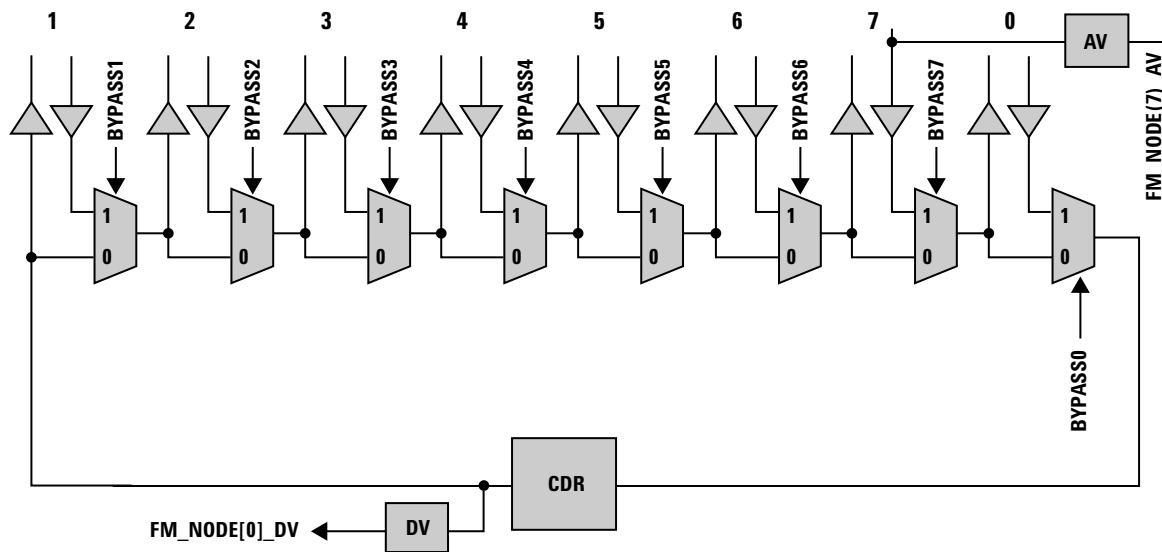


Figure 3. Block Diagram of HDMP-0482, MODE\_VDD is LOW.

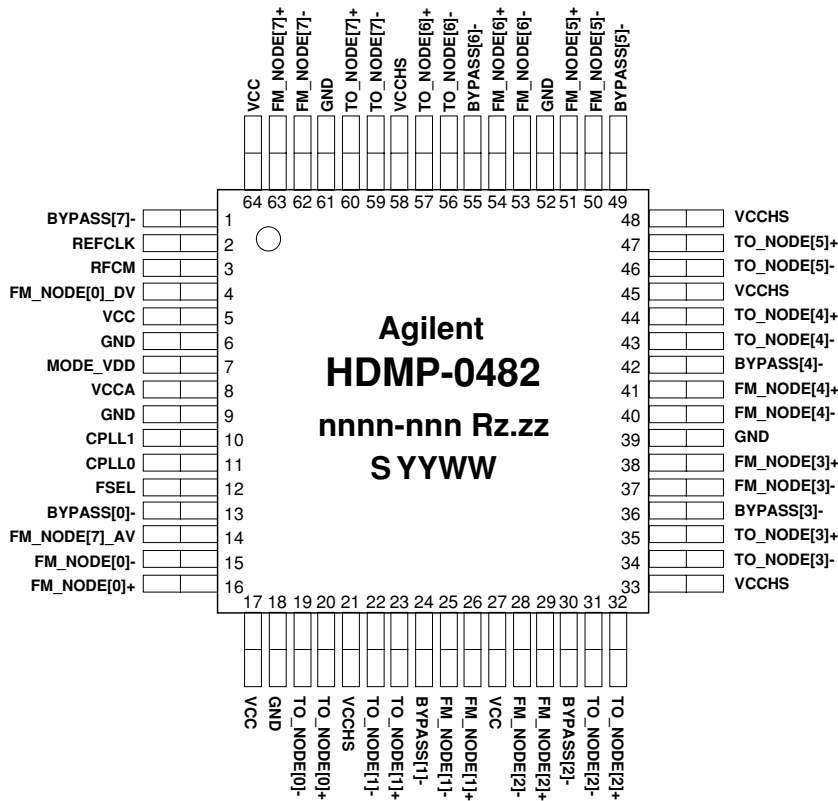
**Table 1. Pin Connection Diagram to Achieve Desired CDR Location.**

Hard Disk	A B C D E F G	A B C D E F G	A B C D E F G	A B C D E F G
Connection to PBC Cell	1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4
CDR Position (x)	x A B C D E F G	A x B C D E F G	A B x C D E F G	A B C x D E F G
Cell Connection to Cable	0	7	6	5

Hard Disk	A B C D E F G	A B C D E F G	A B C D E F G	A B C D E F G
Connection to PBC Cell	5 6 7 0 1 2 3	4 5 6 7 0 1 2	3 4 5 6 7 0 1	2 3 4 5 6 7 0
CDR Position (x)	A B C D x E F G	A B C D E x F G	A B C D E F x G	A B C D E F G x
Cell Connection to Cable	4	3	2	1

x denotes CDR position with respect to hard disks.



**Figure 4. HDMP-0482 Package Layout and Marking, Top View.**

nnnn-nnn = wafer lot - build number; Rz.zz = Die Revision; S = Supplier Code; YYWW = Date Code (YY = year, WW = work week); COUNTRY = country of manufacture (on back side).

**Table 2. I/O Type Definitions.**

I/O Type	Definition
I-LVTTL	LVTTL Input
O-LVTTL	LVTTL Output
HS_OUT	High Speed Output, LVPECL Compatible
HS_IN	High Speed Input
C	External circuit node
S	Power supply or ground

**Table 3. Pin Definitions for HDMP-0482.**

Pin Name	Pin	Pin Type	Pin Description
TO_NODE[0]+	20	HS_OUT	<b>Serial Data Outputs:</b> High-speed outputs to a hard disk drive or to a cable input.
TO_NODE[0]-	19		
TO_NODE[1]+	23		
TO_NODE[1]-	22		
TO_NODE[2]+	32		
TO_NODE[2]-	31		
TO_NODE[3]+	35		
TO_NODE[3]-	34		
TO_NODE[4]+	44		
TO_NODE[4]-	43		
TO_NODE[5]+	47		
TO_NODE[5]-	46		
TO_NODE[6]+	57		
TO_NODE[6]-	56		
TO_NODE[7]+	60	HS_IN	<b>Serial Data Inputs:</b> High-speed inputs from a hard disk drive or from a cable output.
TO_NODE[7]-	59		
FM_NODE[0]+	16		
FM_NODE[0]-	15		
FM_NODE[1]+	26		
FM_NODE[1]-	25		
FM_NODE[2]+	29		
FM_NODE[2]-	28		
FM_NODE[3]+	38		
FM_NODE[3]-	37		
FM_NODE[4]+	41		
FM_NODE[4]-	40		
FM_NODE[5]+	51		
FM_NODE[5]-	50		
FM_NODE[6]+	54		
FM_NODE[6]-	53		
FM_NODE[7]+	63		
FM_NODE[7]-	62		
BYPASS[0]-	13	I-LVTTL	<b>Bypass Inputs:</b> For “disk bypassed” mode, connect BYPASS[n]- to GND through a 1kΩ resistor. For “disk in loop” mode, float HIGH.
BYPASS[1]-	24		
BYPASS[2]-	30		
BYPASS[3]-	36		
BYPASS[4]-	42		
BYPASS[5]-	49		
BYPASS[6]-	55		
BYPASS[7]-	1		
REFCLK	2	I-LVTTL	<b>Reference Clock:</b> A user-supplied clock reference used for frequency acquisition in the Clock and Data Recovery (CDR) circuit.
CPLL1	10	C	<b>Loop Filter Capacitor:</b> A loop filter capacitor for the internal Clock and Data Recovery (CDR) circuit must be connected across the CPLL1 and CPLL0 pins. Recommended value is 0.1 μF.
CPLL0	11		
FM_NODE[7]_AV	14	O-LVTTL	<b>Amplitude Valid:</b> Indicates acceptable signal amplitude on the FM_NODE[7]± inputs. If (FM_NODE[7]+ - FM_NODE[7]-) >= 400 mV peak-to-peak, FM_NODE[7]_AV = 1. If 400 mV > (FM_NODE[7]+ - FM_NODE[7]-) > 100 mV, FM_NODE[7]_AV = unpredictable. If 100 mV >= (FM_NODE[7]+ - FM_NODE[7]-), FM_NODE[7]_AV = 0.
FM_NODE[0]_DV	4	O-LVTTL	<b>Data Valid:</b> Indicates valid Fibre Channel Data on the FM_NODE[0]± inputs when HIGH. Indicates either run length violation error or no comma detected when LOW.
RFCM	3	I-LVTTL	<b>Reference Clock Mode:</b> To configure a one-twentieth-rate reference clock, connect RFCM to GND through a 1kΩ resistor. To configure a one-tenth-rate reference clock, float RFCM HIGH.
MODE_VDD	7	I_LVTTL	<b>Valid Data Detect Mode:</b> To allow data valid detection, float MODE_VDD HIGH. To configure chip for “CDR anywhere” capability, connect MODE_VDD to GND through a 1kΩ resistor.
FSEL	12	I_LVTTL	<b>Frame Select:</b> To configure single-frame operation of the data valid and amplitude valid detection circuits, connect FSEL to GND through a 1k resistor. To configure multi-frame (4-frame) operation of the data valid and amplitude valid detection circuits, float FSEL HIGH.

Table 3 is continued on next page.

**Table 3, continued. Pin Definitions for HDMP-0482.**

Pin Name	Pin	Pin Type	Pin Description
GND	6 9 18 39 52 61	S	<b>Ground:</b> Normally 0 volts. See Figure 11 for Recommended Power Supply Filtering.
VCCA	8	S	<b>Analog Power Supply:</b> Normally 3.3 volts. Used to provide a clean supply line for the Clock and Data Recovery (CDR) circuit. See Figure 11 for Recommended Power Supply Filtering.
VCCHS[0,1]	21	S	<b>High Speed Supply:</b> Normally 3.3 volts. Used only for high-speed outputs (TO_NODE[n]). See Figure 11 for Recommended Power Supply Filtering.
VCCHS[2,3]	33	S	
VCCHS[4]	45	S	
VCCHS[5]	48	S	
VCCHS[6,7]	58	S	
VCC	5 17 27 64	S	<b>Logic Power Supply:</b> Normally 3.3 volts. Used for internal logic. See Figure 11 for Recommended Power Supply Filtering.

**HDMP-0482 Absolute Maximum Ratings**

$T_a = 25^\circ\text{C}$ , except as specified. Operation in excess of any of these conditions may result in permanent damage to this device.  $T_a$  refers to the ambient temperature for the board upon which the parametric measurements were taken.

Symbol	Parameters	Min.	Max.	Units
$V_{CC}$	Supply Voltage	-0.7	4.0	V
$V_{IN, LVTTTL}$	LVTTTL Input Voltage	-0.7	4.0	V
$V_{IN, HS\_IN}$	HS_IN Input Voltage	1.3	$V_{CC}$	V
$I_{O, LVTTTL}$	LVTTTL Output Voltage		$\pm 13$	mA
$T_{stg}$	Storage Temperature	-65	+150	$^\circ\text{C}$
$T_j$	Junction Temperature	0	+125	$^\circ\text{C}$

**HDMP-0482 Guaranteed Operating Rates,  $T_a = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 3.15\text{V}$  to  $3.45\text{V}$**

Serial Clock Rate FC (MBd)		Serial Clock Rate GE (MBd)	
Min.	Max.	Min.	Max.
1,040	1,080	1,240	1,260

**HDMP-0482 CDR Reference Clock Requirements,  $T_a = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 3.15\text{V}$  to  $3.45\text{V}$**

Symbol	Parameter	Min.	Typ.	Max.	Units
f	Nominal Frequency (Fibre Channel)		106.25		MHz
f	Nominal Frequency (Gigabit Ethernet)		125		MHz
Ftol	Frequency Tolerance	-100		100	ppm
Symm	Symmetry (duty cycle)	40		60	%



**HDMP-0482 DC Electrical Specifications,  $T_a = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 3.15\text{V}$  to  $3.45\text{V}$** 

Symbol	Parameter	Min.	Typ.	Max.	Units
$V_{IH,LVTTL}$	LVTTL Input High Voltage Range	2.0		4.0	V
$V_{IL,LVTTL}$	LVTTL Input Low Voltage Range	0		0.8	V
$V_{OH,LVTTL}$	LVTTL Output High Voltage Range, $I_{OH} = -400\ \mu\text{A}$	2.2		3.45	V
$V_{OL,LVTTL}$	LVTTL Output Low Voltage Level, $I_{OL} = 1\ \text{mA}$	0		0.6	V
$I_{IH,LVTTL}$	Input High Current (Magnitude), $V_{IN} = 2.4\ \text{V}$ , $V_{CC} = 3.45\ \text{V}$		.003	40	$\mu\text{A}$
$I_{IL,LVTTL}$	Input Low Current (Magnitude), $V_{IN} = 0.4\ \text{V}$ , $V_{CC} = 3.45\ \text{V}$		300	600	$\mu\text{A}$
$I_{CC}$	Total Supply Current, $T_a = 25^\circ\text{C}$		330	400	mA

**HDMP-0482 AC Electrical Specifications,  $T_a = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 3.15\text{V}$  to  $3.45\text{V}$** 

Symbol	Parameter	Min.	Typ.	Max.	Units
$t_{loop}$	Total Loop Latency from FM_NODE[0] to TO_NODE[0]		2.8	4.2	ns
$t_{cell}$	Per Cell Latency from FM_NODE[7] to TO_NODE[0]		0.5	0.8	ns
$t_{r,LVTTLin}$	Input LVTTL Rise Time Requirement, 0.8 V to 2.0 V		2		ns
$t_{f,LVTTLin}$	Input LVTTL Fall Time Requirement, 2.0 V to 0.8 V		2		ns
$t_{rs,HS\_OUT}$	HS_OUT Single-Ended Rise Time, 20%-80%		200	350	ps
$t_{fs,HS\_OUT}$	HS_OUT Single-Ended Fall Time, 20%-80%		200	350	ps
$t_{rd,HS\_OUT}$	HS_OUT Differential Rise Time, 20%-80%		200	350	ps
$t_{fd,HS\_OUT}$	HS_OUT Differential Fall Time, 20%-80%		200	350	ps
$V_{IP,HS\_IN}$	HS_IN Input Peak to Peak Required Differential Voltage Range	400	1200	2000	mV
$V_{OP,HS\_OUT}$	HS_OUT Output Pk-Pk Diff. Voltage Range ( $Z_0 = 75\ \Omega$ , Fig. 9)	1100	1400	2000	mV

**HDMP-0482 Power Dissipation,  $T_a = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 3.15\text{V}$  to  $3.45\text{V}$** 

Symbol	Parameter	Unit	Typ.	Max.
$P_D$	Power Dissipation	mW	1090	1380

**HDMP-0482 Output Jitter Characteristics,  $T_a = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 3.15\text{V}$  to  $3.45\text{V}$** 

Symbol	Parameter	Unit	Typ.	Max.
RJ	Random Jitter at TO_NODE pins (1 sigma rms)	ps	5	
DJ	Deterministic Jitter at TO_NODE pins (pk-pk)	ps	24	

Please refer to Figures 6 and 7 for jitter measurement setup information.

**HDMP-0482 Locking Characteristics,  $T_a = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 3.15\text{V}$  to  $3.45\text{V}$** 

Parameter	Unit	Max.
Bit Sync Time (phase lock)	bits	2500
Frequency Lock at Powerup	$\mu\text{s}$	500



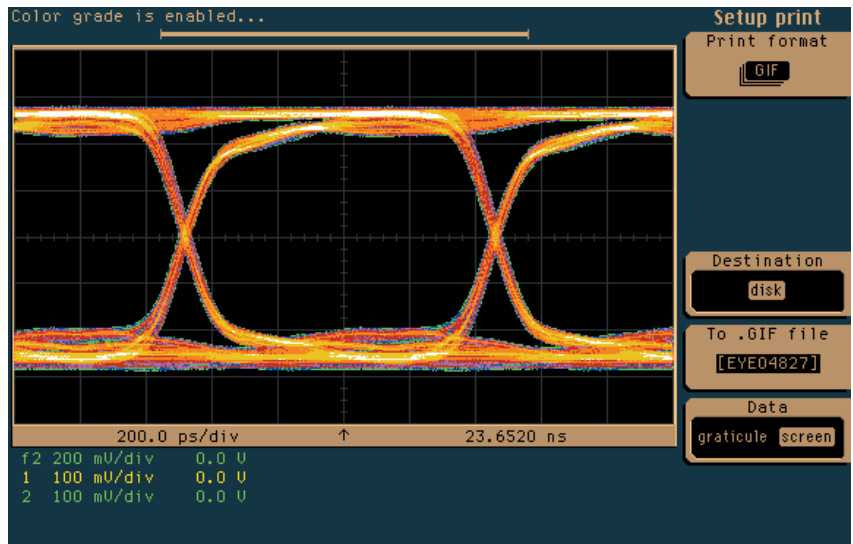


Figure 5. Eye Diagram of TO\_NODE[1]± High Speed Differential Output.

Note: Measurement taken with a 2<sup>7</sup>-1 PRBS input to FM\_NODE[0]±.

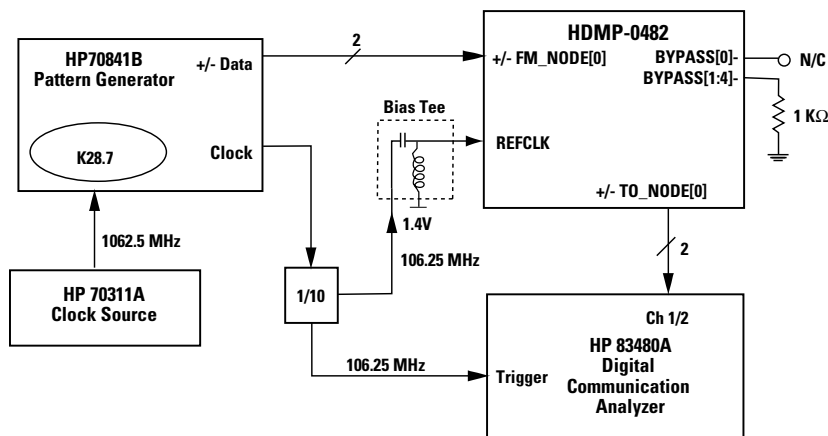


Figure 6. Setup for Measurement of Random Jitter.

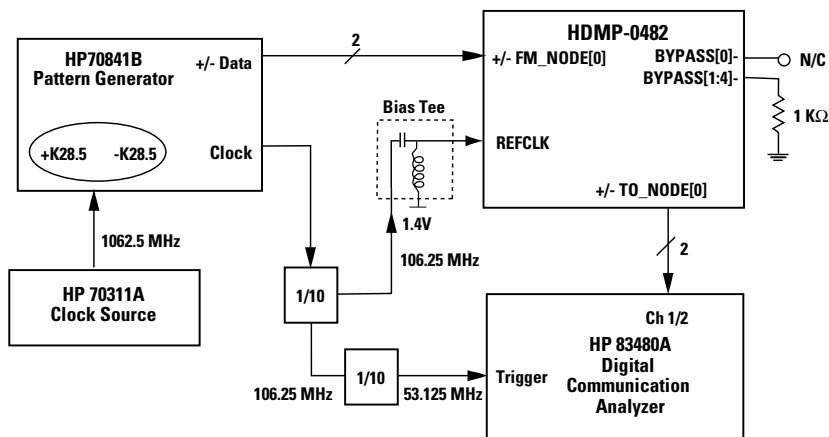


Figure 7. Setup for Measurement of Deterministic Jitter.

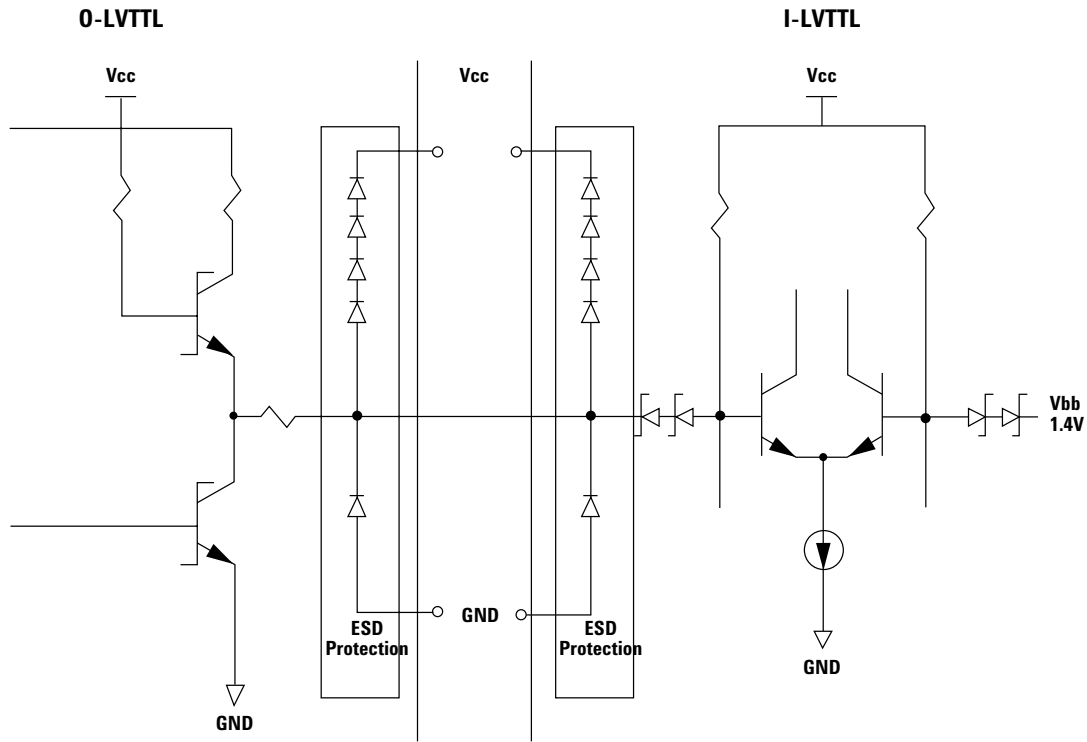


Figure 8. 0\_LVTTL and I\_LVTTL Simplified Circuit Schematic.

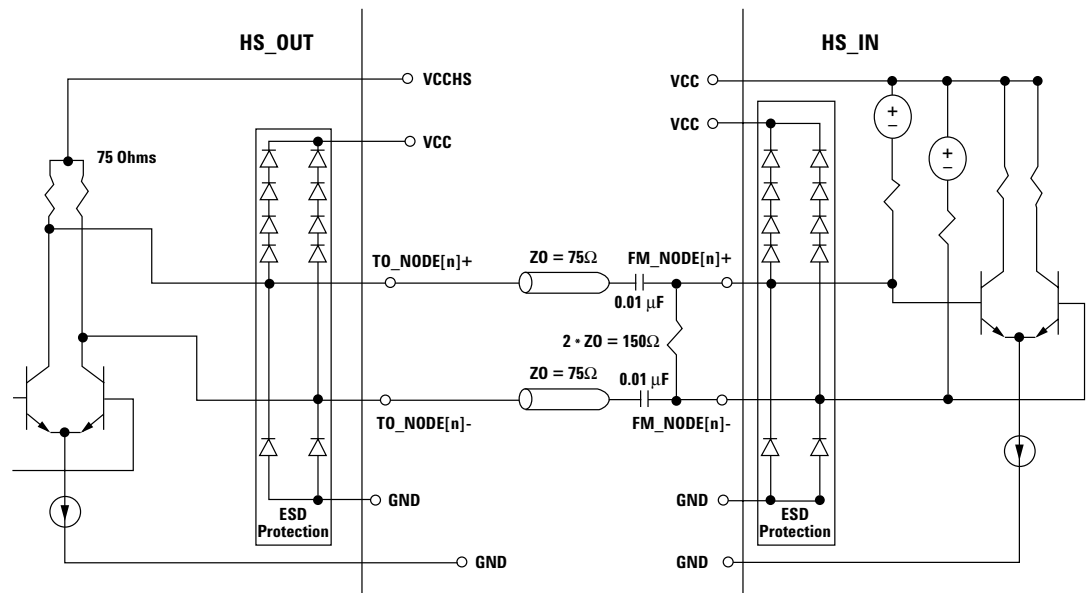


Figure 9. HS\_OUT and HS\_IN Simplified Circuit Schematic.

Note: FM\_NODE[n] inputs should never be connected to ground as permanent damage to the device may result.

## Package Information

**HDMP-0482 Thermal Characteristics**,  $T_C = 0^\circ\text{C}$  to  $85^\circ\text{C}$ ,  $V_{CC} = 3.15\text{V}$  to  $3.45\text{V}$

Symbol	Parameter	Unit	Typ.	Max.
$\theta_{jc}$	Thermal Resistance, Junction to Case	$^\circ\text{C}/\text{W}$	9.5	—

**Note:** Based on independent testing by Agilent.  $\theta_{ja}$  for these devices is  $39.4^\circ\text{C}/\text{W}$  for the HDMP-0482.  $\theta_{ja}$  is measured on a standard  $3 \times 3$ " FR4 PCB in a still air environment. To determine the actual junction temperature in a given application, use the following equation:  $T_j = T_C + (\theta_{jc} \times P_D)$ , where  $T_C$  is the case temperature measured on the top center of the package, and  $P_D$  is the power being dissipated.

Item	Details
Package Material	Plastic
Lead Finish Material	85% Tin, 15% Lead
Lead Finish Thickness	300–800 micro-inches
Lead Skew	0.20 mm max.
Lead Coplanarity (Seating Plane Method)	0.10 mm max.

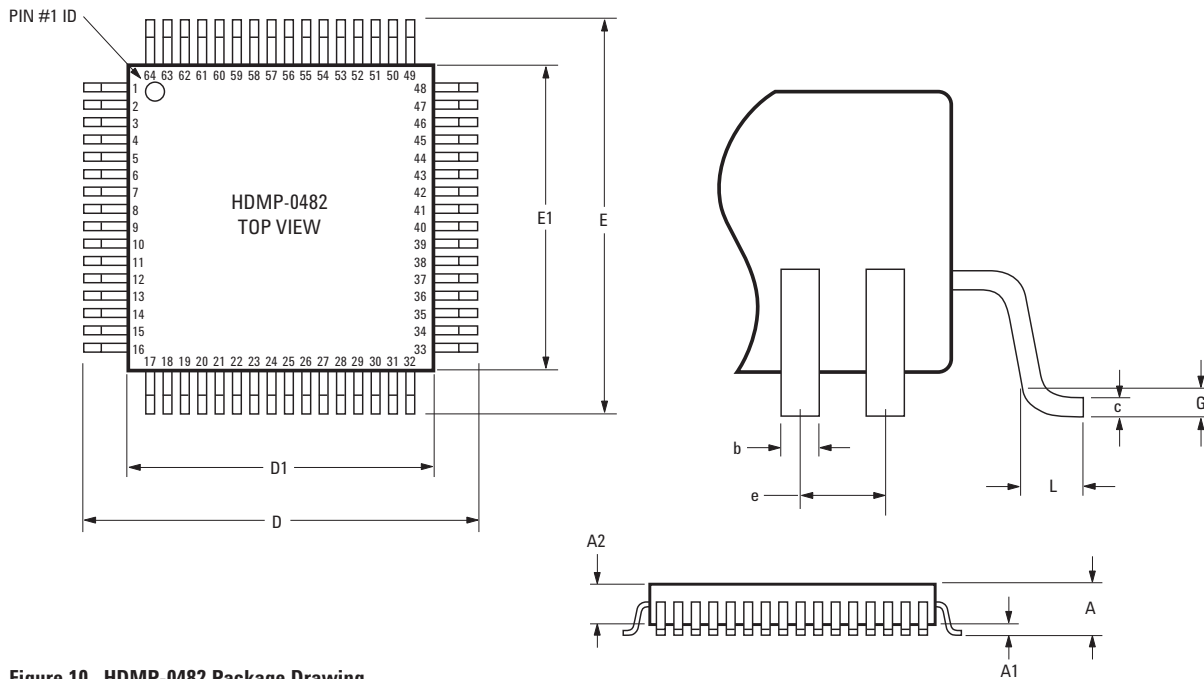


Figure 10. HDMP-0482 Package Drawing.

### Mechanical Dimensions of HDMP-0482

Dimensional Parameter (in millimeters)	D1/E1	D/E	b	e	L	c	G	A2	A1	A
HDMP-0482	14.00	17.20	0.35	0.80	0.88	0.17	0.25	2.00	0.25	2.35
Tolerance	$\pm 0.10$	$\pm 0.25$	$\pm 0.05$	Basic	+0.15/ -0.10	Max	Gage Plane	+0.10/ -0.05		Max

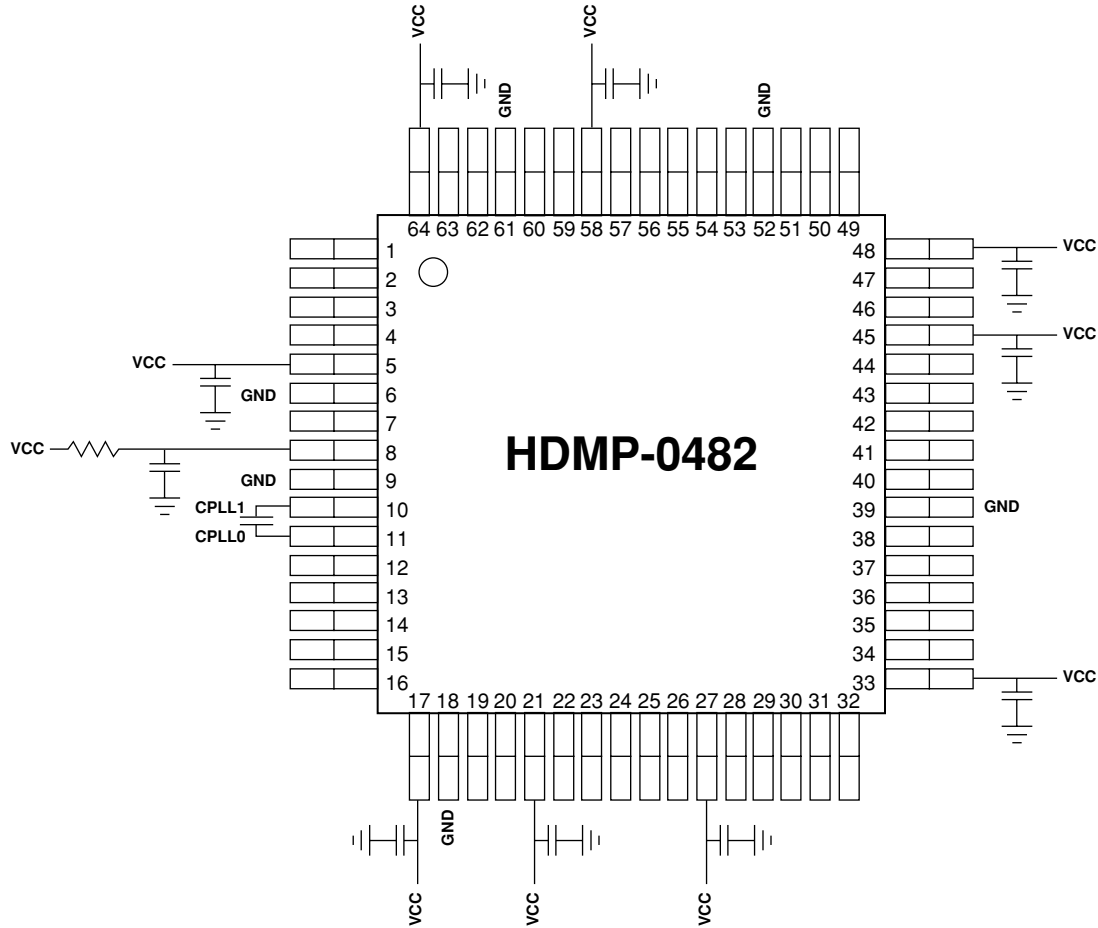


Figure 11. Recommended Power Supply Filtering. Capacitors = 0.1  $\mu$ F, Resistor = 10 $\Omega$ .

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