Fast Ethernet Fiber to TP Media Converter

- Single chip 100 Mbit/s fiber optic to twisted pair media converter
- Low latency
- Integrated elastic store for retiming
- Supports a secondary channel for management
- Full duplex capable
- Link fault propagation
- PECL interface
- Supports Auto-negotiation to full duplex
- Remote fault detection capable
- Provides support for redundant link
- 80mA drive capability
- Fabricated in CMOS and 48-pin PQFP package

Product Description

The AL211 is designed for media converter applications. It is intended for 100 Mbit/s Fast Ethernet fiber optic to twisted pair media converter designs. The device also provides a PECL interface for use with media connectors such as 1300nm fiber optic modules. The AL211 is compatible with IEEE 802.3 100Base-FX and 100Base-TX standards.

The integrated media converter provides additional functionality such as fault propagation and redundant link support that conventional implementations using discrete components typically can not support. The AL211 also provides a secondary channel for inband management information exchange.

The AL211 includes: elastic store, scrambler, and descrambler functions to complete the media converter design.

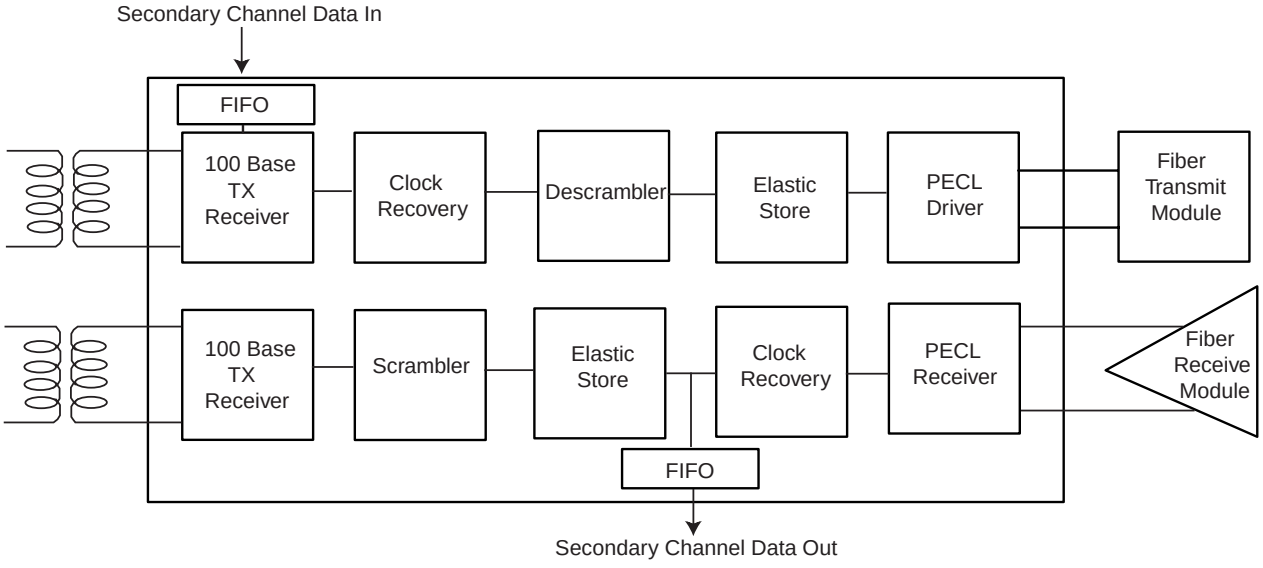

Figure 1-1 System Block Diagram

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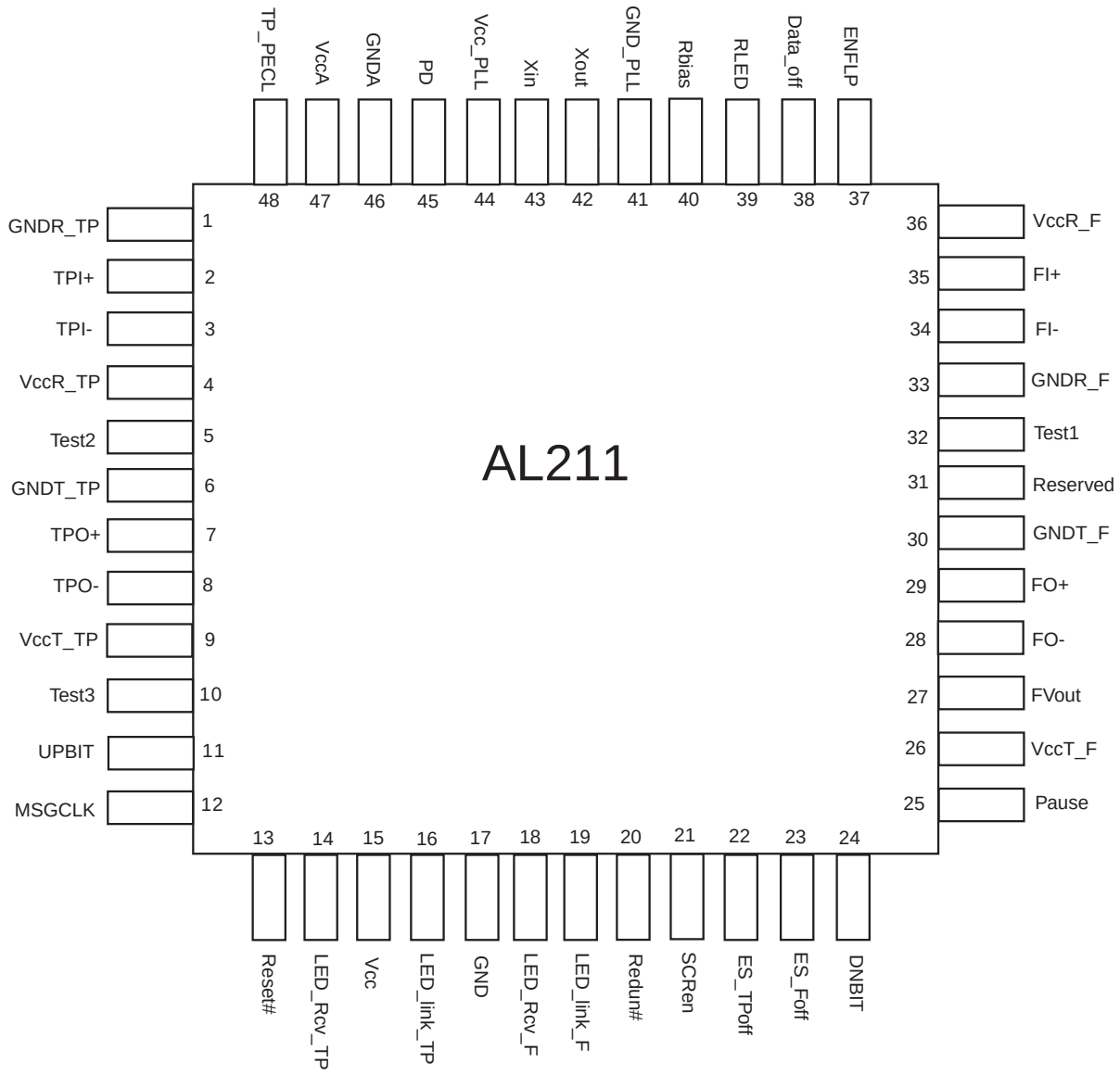

Figure 1-2 AL211 Pin Out

1. Pin Descriptions

Table 1: AL211 Pin Description

PIN NUMBER	PIN NAME	I/O	DESCRIPTION
1	GNDR_TP	P	TP Receive Ground.
2 3	TPI+ TPI-	I	100Base-TX Receiver Input Data. During normal operation, the pins receive MLT3 signals and are connected to a transformer. When the TPPECL pin is pulled high, these pins become a PECL level interface. It can then be used for interfacing to an external equalizer chip for added distance.
4	VccR_TP	P	TP Receive Power Supply.
5	Test2	I	Test Pin. Tied low for normal operation. Tied high to force TP output enable.
6	GNDT_TP	P	TP Transmit Ground.
7 8	TPO+ TPO-	O	100Base-TX Transmit Data. During normal operation, the pins transmit MLT3 signals and are connected to a transformer. When the TPPECL pin is pulled high, these pins will transmit PECL NRZI signals for interface to an external equalizer chip.
9	VccT_TP	P	TP Transmit Power Supply.
10	Test3	I	Test Pin. Tied low for normal operation. Tied high to force Fx output “idle” when TP link is down.
11	UPBIT	I	Secondary Channel Data Input. Internal pull up.
12	MSGCLK	I	Secondary Channel Clock. Internal pull up.
13	Reset#	I	Reset Pin. Active low. Internal pull up.
14	LED_Rcv _TP	O	TP Receiving Activity Output Status Pin. It will be active low when the device is receiving frames on the TP side. It is an open drain driver capable of driving a 10mA LED.
15	Vcc	P	Digital Circuit Power Supply. (+5V)
16	LED_link _TP	O	TP Link Detect Output Status Pin. It will be low when TP link is detected. It is capable of driving a 10mA LED.
17	GND	P	Digital Circuit Ground.
18	LED_Rcv_F	O	Fiber Receiving Activity Output Status Pin. It will be active low when the device is receiving frames on FB site. It is an output driver capable of driving a 10mA LED.

Table 1: AL211 Pin Description (Continued)

PIN NUMBER	PIN NAME	I/O	DESCRIPTION
19	LED_link_F	O	Indicates Fiber Link Status. A steady ON LED indicates a good fiber link. A blinking LED indicates a remote fault detected. A OFF LED indicates no fiber link detected. It is an open drain driver capable of driving a 10mA LED.
20	Redun#	O	Redundant Link Output Pin. The pin will be asserted (LOW) if the device is in either the link-fail state or if it senses a remote fault condition.
21	SCRen	I	Scrambler Enable for TP Port Output. Active high, internal pull up.
22	ES_TPoff	I	Elastic Store of TP to Fiber Path Disable. Active high, internal pull down.
23	ES_Foff	I	Elastic Store of Fiber to TP Path Disable. Active high, internal pull down.
24	DNBIT	O	Secondary Channel Data Out.
25	Pause	I	Pause Capability Advertisement Enable. Active high, internal pull up.
26	VccT_F	P	Power Supply. (+5V)
27	Reserved	O	Leave unconnected.
28 29	FO- FO+	O	PECL output pins for driving the fiber optic module.
30	GNDT_F	P	Fiber Transmit Ground.
31	Reserved	I	Tied high or leave floating.
32	Test1	I	Test Pin. Tied low for normal operation.
33	GNDR_F	P	Fiber Receive Ground.
34 35	FI- FI+	I	PECL input pins for driving the fiber optic module.
36	VccR_F	P	Fiber Receiver Power Supply. (+5V)
37	ENFLP	I	Enables Full Duplex Auto-negotiation FLP. Active high, internal pull up.
38	Data_off	I	Assertion of this pin turns off the TP port output. Deassertion will enable the AL211 to pass data to the TP port. Internal pull down.

Table 1: AL211 Pin Description (Continued)

PIN NUMBER	PIN NAME	I/O	DESCRIPTION
39	RLED	I	Transmit Output LED Drive Control. Tied to ground through a 12.8K 1% resistor. When this pin is tied high, it will disable the current mode output driver and enable the voltage mode driver.
40	Rbias	I	Bias Control of the AL211. Tied to ground through a 12.8K 1% resistor.
41	GND_PLL	P	Phase Locked Loop Ground.
42	Xout	O	25 MHz Crystal Connection. This pin also sources the clock output.
43	Xin	I	25 MHz Crystal Connection. If a clock is used instead of a crystal, this is the input pin of the clock.
44	Vcc_PLL	P	Phase Locked Loop Power Supply.
45	PD	I	Power Down. Active high, internal pull down.
46	GNDA	P	Analog Ground.
47	VccA	P	Analog Power.
48	TP_PECL	I	TP Port PECL Interface Enable. When set to high, the TPI+, TPI-, and TPO+, TPO- pins become PECL level interface. It also disables the MLT3 encoder/decoder. When the PECL level interface is used, the signals expected by the chip are NRZI instead of MLT3. Internal pull down.

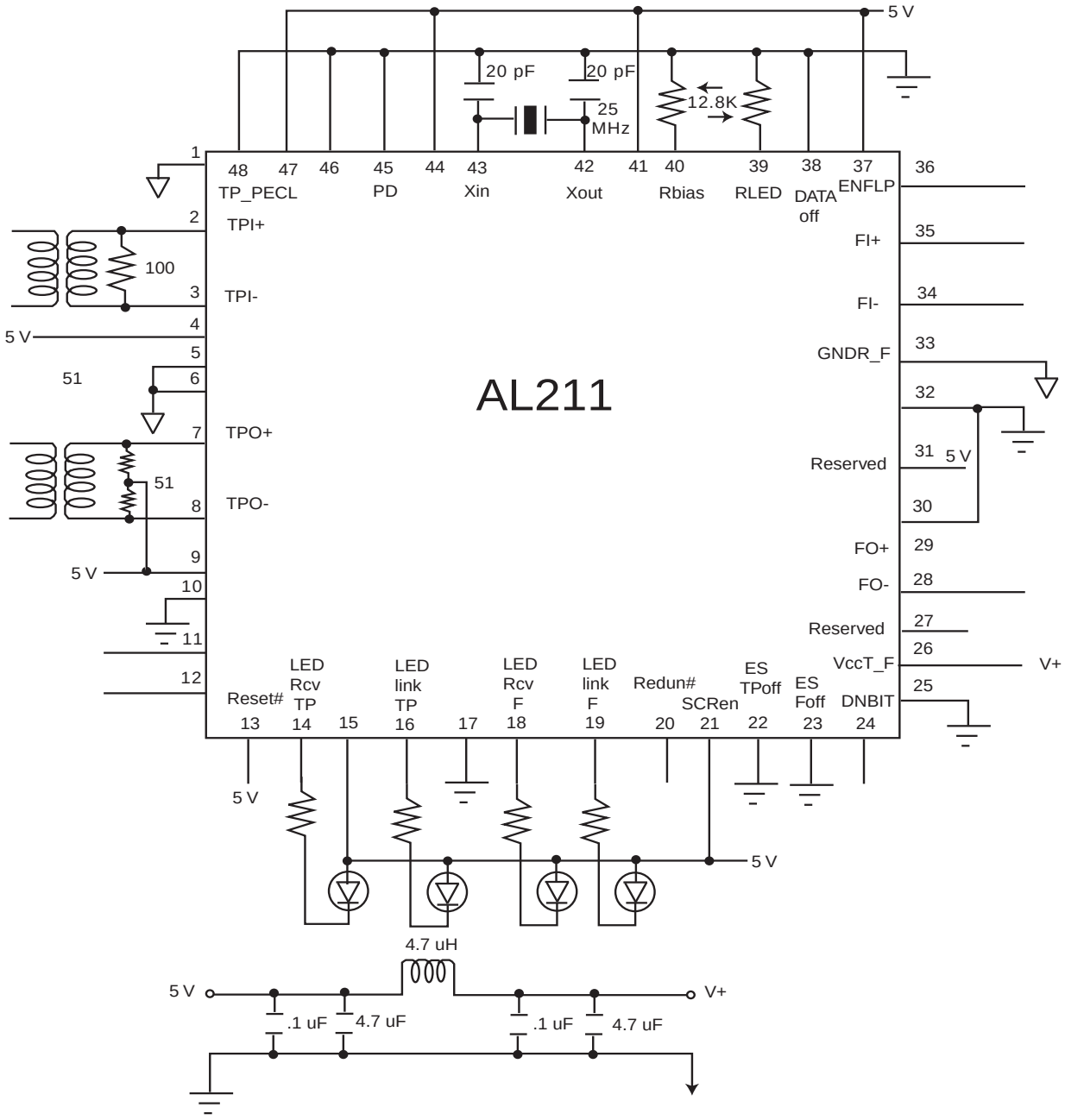

Figure 1-3 AL211 Typical Application Circuit

2. Functional Description

The AL211 contains a physical layer interface (PHY) device for IEEE 802.3 100Base-TX and a PHY for 100Base-FX networks. The PHY contains all the necessary functions such as elastic store and driver circuits to complete a media converter design. The device converts the MLT3 scrambled symbols from the twisted pair (TP) input port into 4B5B NRZI encoded data and transmits it over the fiber media. The 4B5B NRZI encoded data from the fiber-input port is converted to a scrambled MLT3 symbol stream for TP transmission.

The AL211 does not encode or decode the 4B5B symbols, therefore all errors and signaling are preserved and propagated. In addition, the benefit of a “straight-through” conversion is that the latency can be as low as 8-bit time (BT). The device also supports Far-End Fault Detection (fiber only) and Link Status Propagation. If any port is in a link-fail state, the device will cease to transmit data and disables the appropriate output port. In essence, the device is transparent in regard to the connecting links.

The AL211 provides a PECL interface for interfacing either to an equalizer chip or a fiber module.

An elastic store is provided by the media converter to retime the received signal. The elastic store can be disabled to reduce latency of the converter.

The AL211 supports redundant link applications. A redundant link can be formed by either a switch with 100Base-FX transceiver that supports far-end fault signaling or two AL211’s. In the event of a link-failure, the redundant link will be established automatically.

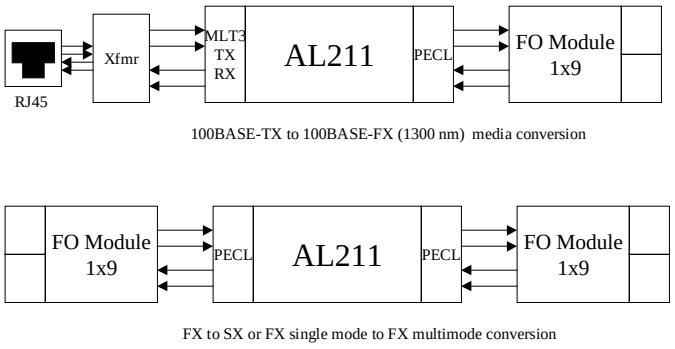

Figure 1-4 AL211 Applications

2.1 100Base-TX to 100Base-FX Conversion

The AL211's 100Base-TX receiver is designed for data reception of up to a maximum of 10 meters of Category 5 Cable. For applications that require the full IEEE 802.3 distance (100 meters), the AL211 provides PECL interface to interface to an external equalizer chip. However, media converter applications are typically within the wiring closet. A distance of 10 meters is adequate to support these applications.

After the scrambled MLT3 signal from the twisted pair port is received by the AL211, the device descrambles the signal and converts it into a NRZ signal stream. The signal is then passed through an elastic store for retiming. The resulting signal is then converted into a serial NRZI bit stream and sent to the LED driver. The elastic store can be disabled to reduce the latency of the converter.

During idle, the AL211 will transmit an IDLE signal. If the twisted pair port is in a link-down state, the AL211 will cease to transmit any signal and link fault is thus propagated.

2.2 100Base-FX to 100Base-TX Conversion

The AL211 100Base-FX receiver is comprised of a scrambler and a quantizer. After receiving the serial bit stream from the PIN amplifier, the device passes the signal through an elastic store for retiming and converts the NRZI coded data into a scrambled MLT3 signal and sends it to the 100Base-TX transmitter.

During idle, the AL211 will transmit the scrambled IDLE signal. If the fiber receiver does not receive any idle signal, the fiber port will go into a link-down state and the AL211 will perform two tasks:

1. Cease to transmit any signal to the TP port and put the transmit TP port in high impedance; and
2. Simultaneously start transmitting far-end fault signals.

In the event of remote fault (the receiver receives the far-end fault signal), the receiver will go into a link-down state. The RF LED provides the remote fault signal status indication. The far-end fault signal is indicated by the far-end fault IDLE signal (84 "ones" follow by a "zero").

When the fiber port is in a link-down state (either remote fault or receive link-fail), the device will put the TP output port into high impedance and assert Redun# signal.

2.3 Secondary Channel

The AL211 provides a secondary serial communication channel. This serial port is intended as a point to point communication link piggybacked to the 100 Mbit/s data stream over the fiber. The data is input and retrieved from the AL211's media conversion device serial port.

The secondary channel data is transmitted during the IPG of the normal transmission stream. During idle (or IPG), the AL211 will insert a 10-bit code word and an 8-bit data into the transmit data stream. When a regular data transmission is in progress, the secondary channel will remain idle. The data written into the AL211 will be stored in the on-chip FIFO.

If additional data is written into the AL211 before the stored data has been sent, it will write over the previous data. Figure 1-5 illustrates the secondary channel data format.

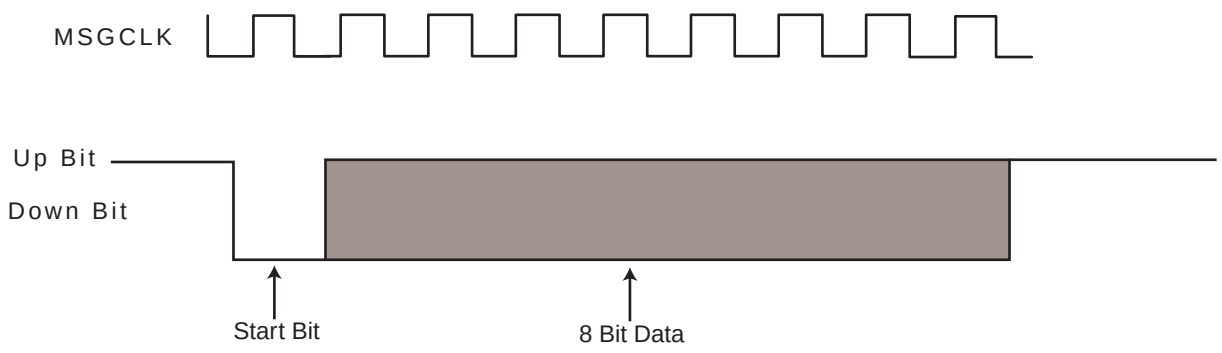

Figure 1-5 Secondary Channel Data Format

The clock rate can be as high as 25 MHz, however the data rate is limited by the IPG between frame. The worst case data rate is 8 Kbit/s which is based on the calculation of 1518 bytes of data interleaved with 8-bit of secondary channel data.

2.4 Full Duplex Application

The ideal function of a media converter chip is to provide a full duplex transparent media link. However, because the 100Base-FX does not support auto-negotiation, the AL211 can not propagate duplex information to the twisted pair media. Although the AL211 does not support full auto-negotiation, it provides an option to force the link partner into full duplex mode with auto-negotiated link pulses. When Pin 37, (ENFLP) is pulled high, the AL211 will transmit auto-negotiation FLP with 100 Mbit/s full duplex capability field forcing the linked unmanaged switch into full duplex.

2.5 PECL Interface

The AL211 provides an PECL interface to the TP interface and fiber connect interface. The intention of the interfaces are to allow design engineers to be able to choose other media interconnects such as a 1300nm fiber module or external twisted pair equalizer.

The AL211 has the signal detect function built in and does not require any interface to the signal detect input.

2.6 Elastic Store

The AL211 provides an on-chip elastic store. With the elastic store in place, the device retimes the received signal and removes jitter. The elastic store can be turned off to reduce latency of the device by using the appropriate pins.

For typical applications such as media conversion to a 100Base-FX hub, where the twisted pair length is less than 10 meters and fiber length is less than 400 meters (reference to IEEE 802.3 clause 29 for fiber length and system configuration), retiming is not needed.

For full duplex application of fiber length over 2km, the elastic store should be used to remove the jitter from the signal.

2.7 Scrambler

The AL211 can also be used as a full duplex media extender or 850nm to 1300nm media converter by turning the scrambler off. To turn the scrambler off, the pin SCRen should be connected to ground.

2.8 Fault Propagation

The AL211 will propagate the idle signals from media to media. After reception of the idle signal (all “1s”), the device will then transmit an idle signal to the opposite ports, i.e. TP to fiber or fiber to TP. There are two types of link-failure; receive or remote fault (also known as far-end fault).

1. TP receive link-failure. In the event of a TP receive link-failure, the AL211 will cease to transmit an idle signal to the fiber optic driver. A valid TP link signal can be either a 10Base-T link pulse or a 100Base-TX idle signal.
2. Fiber receive link-failure. In the event of a fiber receive link-failure, the AL211 will cease to transmit an idle signal to the TP driver and put the driver into high impedance. The device will also send a remote fault signal to the fiber optic driver in addition to asserting the Redun# signal.
3. TP transmit link-failure. In the event of a TP transmit link-failure, the TP far-end transceiver will cease to transmit an idle signal and start transmitting FLP to the AL211. Since the AL211 does not understand FLP, it will continue to transmit an idle signal to the fiber optic driver.
4. Fiber transmit link-failure. In the event of a fiber transmit link-failure, the far-end transceiver (with remote fault signaling capability) will transmit an RF signal to the AL211. As a result, the AL211 will perform two tasks: cease to transmit an idle signal to the TP driver and put the driver into high impedance asserting the Redun# signal.

2.9 Redundant Link

The AL211 supports redundant link through the use of DATAoff and Redun# signals. The redundant link function is only available for the FO port. An implementation of a redundant link is shown in Figure 1-6. A redundant link can also be configured with two fiber switch ports (far-end fault signaling support required) and two AL211’s.

There are two likely scenarios; either the transmit link fault or the receive link fault could trigger the redundant link.

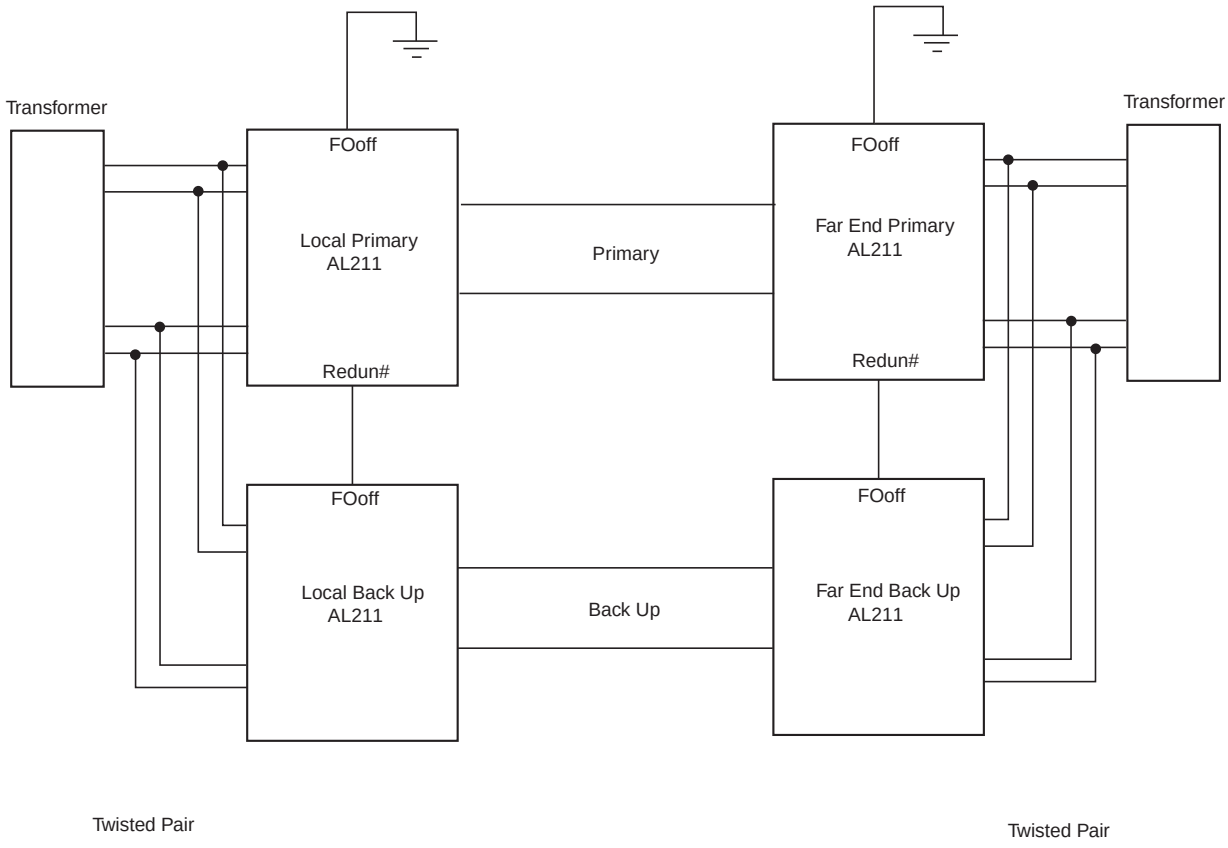

Figure 1-6 Redundant Link

2.9.1 Receive Link Fault

In the event of a receive link-failure, the receiver will go into a link-down mode. The AL211 will take the following actions:

1. Start transmitting remote fault signal; and
2. Put the TPO+ and TPO- pins in high impedance; and
3. Assert Redun# signal.

The far-end primary transceiver is normally in a link-up state and a back-up transceiver in a link-fail state. During receive link-failure, the local AL211 will enable data transmission of the backup transceiver by asserting the Redun# signal. The backup AL211 will then start sending copies of the transmit signal.

The primary far-end receiver that receives the RF signal will enter the link-fail state. The back-up transceiver will exit the link-fail state upon receiving a signal from the local AL211 re-establishing the link. When the primary link is repaired, Redun# will be de-asserted and the secondary link will be turned off re-establishing the primary link. During normal operation, the backup channel will be transmitting idle signals but not data. Therefore, the link integrity status of the back-up channel is available through the LED indicator.

2.9.2 Transmit Link Fault

The 100Base-FX specification provides a way to detect transmit link-failure. Whenever a fiber receiver experiences receive link-failure, it will transmit a far-end fault signal. The far-end fault signal is indicated by the far-end fault IDLE signal (84 “ones” follow by a “zero”).

When the AL211 receives the far-end fault signal, it is notified by the far-end station that a transmit fault has occurred. The device will go into a link-down state and will take the following actions:

1. Put the TPO+ and TPO- pins in high impedance; and
2. Assert Redun# signal.

The data transmission will be assumed by the backup AL211 and start sending copies of the signal. Upon re-establishment of the primary fiber, Redun# will be de-asserted and the backup data link will be turned off.

2.9.3 Redundant Link with Switches or Repeater

Figure 1-7 shows a redundant link implemented by a pair of AL211’s and a fiber switch/repeater. The key to this configuration is that the transceivers of the fiber switch must support far-end fault signaling (although the IEEE far-end fault signaling is an option).

The operation of this link configuration is very similar to the AL211 redundant link as described above. Instead of the far-end transceivers being switched, the ports are now switched. Whenever, the far-end transceiver receives the far-end fault signal or no IDLE signal, it will enter the link-fail state. Thus, redundancy is accomplished.

There is no limit on the number of redundant links for the AL211. Also the Redun# and Data_off signals can be cascaded as many times as it needs to offer two or more redundant links.

One minor disadvantage of this scenario with a switch, is that the link will not be functional (spanning tree will cut off the port) until the addresses stored in the switch are aged out. However, many of the switches today automatically delete the old address when there is a change of address. With that feature, the link will be immediately established.

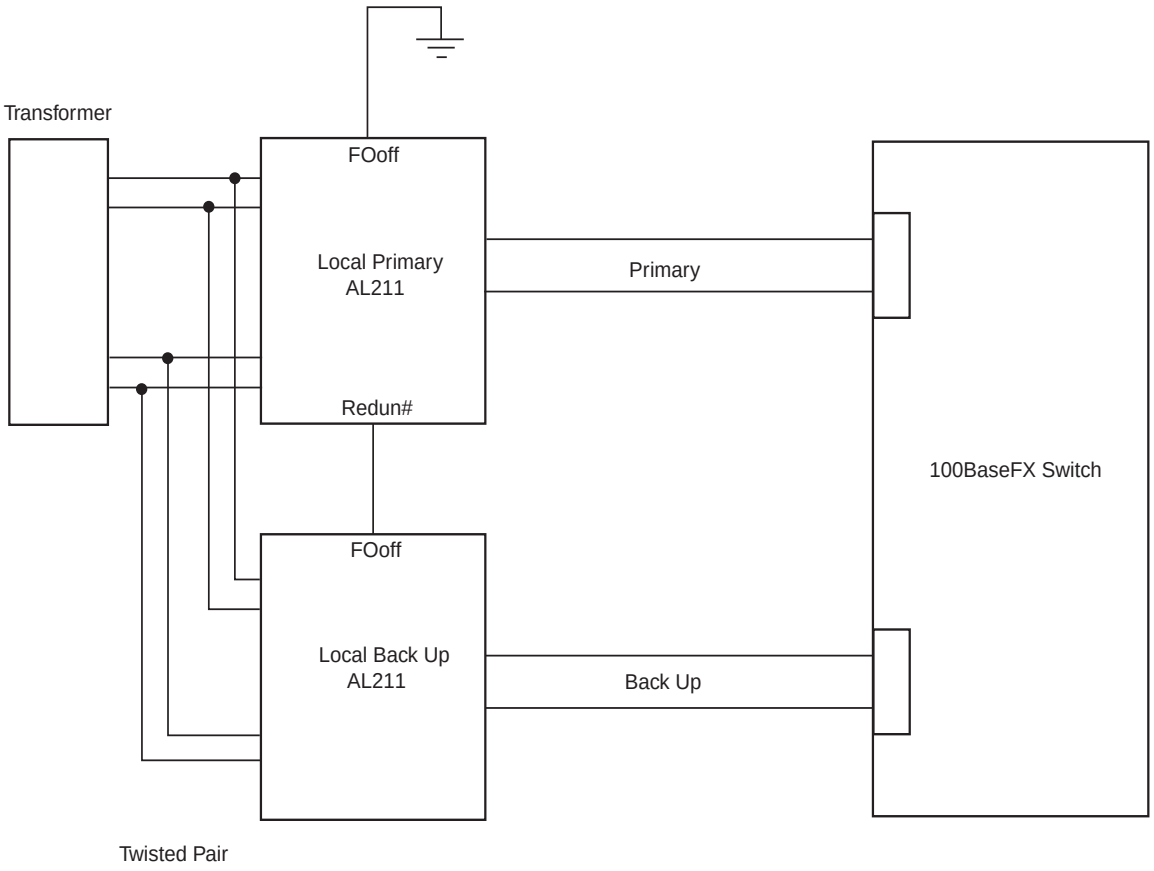

Figure 1-7 Redundant Link Application with Switch

2.10 LED Indicators

The AL211 provides four LED drivers which consist of activity and link indicators for both TP and fiber. If the AL211 experiences a remote link fault, the link LED (fiber only) will flash in 0.5 second intervals.

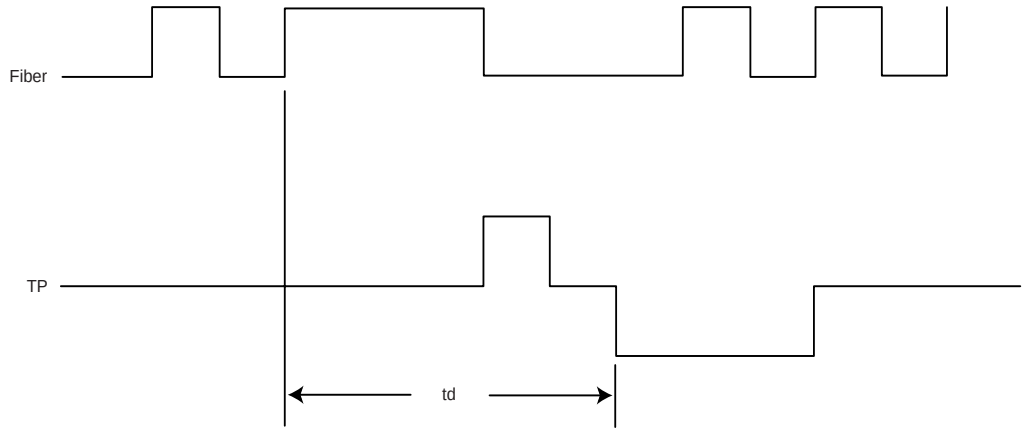

Figure 1-8 Fiber to TP Latency

Table 2: Fiber to TP Latency Parameters

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
td	Fiber to TP latency without elastic store.	-	90	-	ns
td	Fiber to TP latency with elastic store.	-	120	-	ns

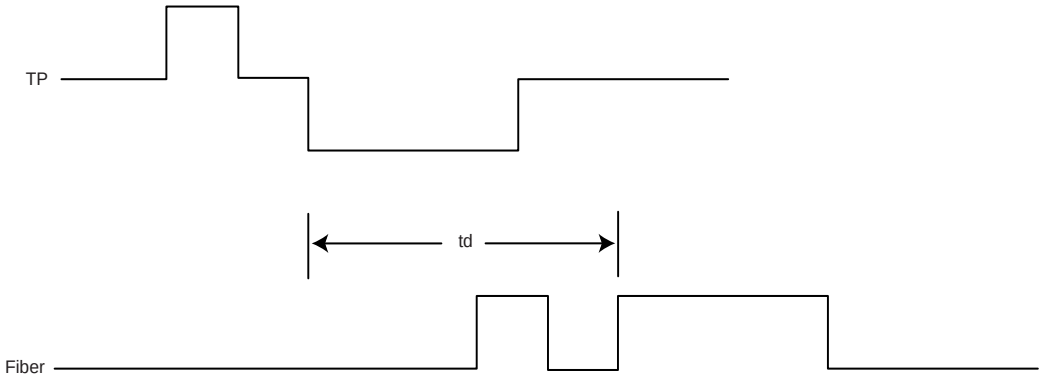

Figure 1-9 TP to Fiber Latency

Table 3: TP to Fiber Latency Parameters

PARAMETER	DESCRIPTION	MIN	TYP.	MAX.	UNITS
td	TP to Fiber latency without elastic store.	-	90	95	ns
td	TP to Fiber latency with elastic store.	-	120	-	ns

3. Electrical Specifications

Note: Operation at absolute maximum ratings outside those listed could cause permanent damage to the device.

Table 4: Maximum Ratings

DC Supply Voltage (Vcc)	-0.5V ~ +6V
DC Input Voltage	-0.3 ~ Vcc + 0.3V
DC Output Voltage	-0.3 ~ Vcc + 0.3V
Storage Temperature	-55 ^{o}C to +150 ^{o}C

Table 5: Recommended Operation Conditions

Supply Voltage	5.0 V ± 10%
Operating Temperature	0 - 70 ^{o}C
Power Dissipation	0.9W (Tx to 850nm LED) 0.65W (Tx to PECL) 0.6W (PECL to PECL)

Note: Under Recommended Operating Conditions, Vcc=5.0V ± 10%, ta = 25 °C.

Table 6: DC Electrical Characteristics

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Vcc	Supply voltage.	4.5	5.0	5.5	V
Voh	Output voltage-high, Ioh=24mA.	2.4	-	-	V
Vol	Output voltage-low, Ioh=24mA.	-	-	0.4	V
Ioz	High impedance state output current.	-1	-	1	uA
Iih (1)*	Input current-high.	-	-	-	uA
Iil (1)*	Input current-low.	-	-	-	uA
Iih (2)*	Input current-high with internal pull down.	-	-	50	uA
Iil (2)*	Input current-low with internal pull down.	-35	-	-	uA
Vih	Input high voltage.	0.7*Vcc	-	-	uA
Vil	Input low voltage.	-	-	0.3*Vcc	-
Icc	Supply current.	-	-	-	mA
Vrx	Receiver input voltage.	5	-	1600	mV
Tr	Transmitter rise time.	-	-	1.3	ns
Tf	Transmitter fall time.	-	-	1.3	ns

Note: A * in the parameter column indicates digital control signals only.

4. AL211 Mechanical Data

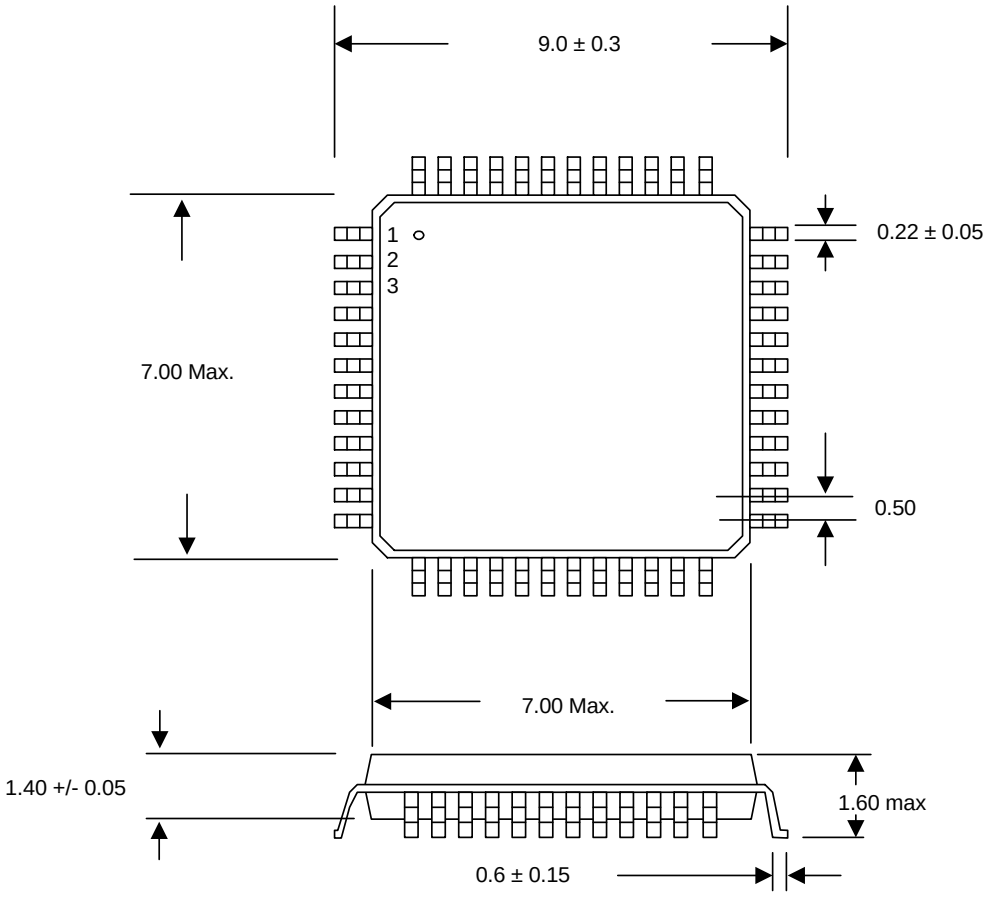

Figure 1-10 AL211 Mechanical Dimensions

Rev. History

Preliminary 1.1 to 1.2

1. Corrected system block diagram.
2. Corrected pin out illustration.
3. Updated pin descriptions (numbers 26-36).
4. Updated typical application circuit.

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