DM/SP7041-X

1000BASE-T SFP

Auto-Negotiation

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SFP Auto-Negotiation
There are two types of Auto-Negotiation that operate simultaneously within the SFP module:

- The standard IEEE 802.3u Clause 28 copper Auto-Negotiation. This is 1000Base-T Auto-Negotiation on media side between PHY and link partner.

- The 8B/10B encoded 1000BASE-X Auto-Negotiation on the host side between the PHY and the MAC. This Auto-Negotiation follows the IEEE 802.3z Clause 37 1000BASE-X Auto-Negotiation state machine as described in Figure 37-6.

From the MAC point of view, the MAC is driving a fiber transceiver (assuming the SERDES is embedded in the MAC). From this MAC point of view, the acknowledgements that the MAC is getting during the Auto-Negotiation process are coming from the remote link partner. Actually, no fiber transceiver is present. The 1000BASE-X Auto-Negotiation is done by the PHY on the SFP side of the transceiver. The PHY uses the 1000BASE-X information that it receives from the MAC to adjust the configuration options that it advertises during copper Auto-Negotiation.

The speed is fixed at 1000 Mbps. Therefore, the only configuration options available are duplex and flow control. The PHY holds back acknowledgement to the MAC until the copper Auto-Negotiation is resolved and then sends the 1000BASE-X Auto-Negotiation and acknowledgement information to the MAC. In this way, the MAC can complete Auto-Negotiation without knowing that the copper Auto-Negotiation was involved. This feature is very useful for SFP applications that already have 1000BASE-X Auto-Negotiation enabled for fiber SFP applications. Therefore, there is no need to change the software when a copper SFP is used.

- The PHY changes what it advertises on the copper side based on the 1000BASE-X Auto-Negotiation information it receives from the MAC. (However, the PHY does not change register 4 contents, which still show the strap option latched values or the values written by the serial management access using the MDC/MDIO or the BDT interface.)
- The MAC has to resolve flow control.
- The PHY resolves duplex. The speed is fixed at 1000 Mbps

SFP 1000Base-X Auto-negotiation Bypass Mode
The 1000Base-X Auto-Negotiation bypass feature allows the SFP to work with the MAC whether it has 1000Base-X Auto-Negotiation turned ON or OFF. This feature is enabled by default so no software intervention is required. With 1000Base-X Auto-Negotiation set to ON, the transceiver can automatically switch to bypass mode in order to work with a non-auto-negotiating MAC. In the bypass mode, the transceiver turns off 1000Base-X Auto-Negotiation so it can transmit/receive data to/from the non-auto-negotiating MAC properly. The transceiver will first wait for the 1000Base-T link to come up. After the 1000Base-T link is up, it will wait for 200ms. If during this time only idles are received from the MAC it will go to bypass mode. 1000Base-X Auto-Negotiation bypass can be controlled through register27.12. The default setting is 1 which means that the feature is enabled. Writing a 0 to register27.12 followed by a software reset (register0.15=1) will disable this feature.

SFP Status/Control Registers
Register 0,1,4,5,6,7,8,17,18 and 19 are internally divided into 2 separate register sets. One set of registers is used for 1000Base-T status/control and the other set is used for 1000Base-X status/control. When register 22 is set to 0000001, the 1000Base-X register set is selected. When register 22.7:0 is set to 00000000, the 1000Base-T register set is selected.

Here are some examples:

To turn on 1000Base-X auto-negotiation:
Write Reg22.7:0=00000001 select 1000Base-X registers
Write Reg0=0x9140 turn on auto-negotiation bit and apply software reset

To turn off 1000Base-X auto-negotiation:
Write Reg22.7:0=00000001 select 1000Base-X registers
Write Reg0=0x8140 turn off auto-negotiation bit and apply software reset

To display 1000Base-T auto-negotiation information for local device:
Write reg22.7:0=00000000 select 1000Base-T registers
Read reg4 local device auto-negotiation information

To display 1000Base-X auto-negotiation information for local device:
Write reg22.7:0=00000001 select 1000Base-X registers
Read reg4 local device auto-negotiation information

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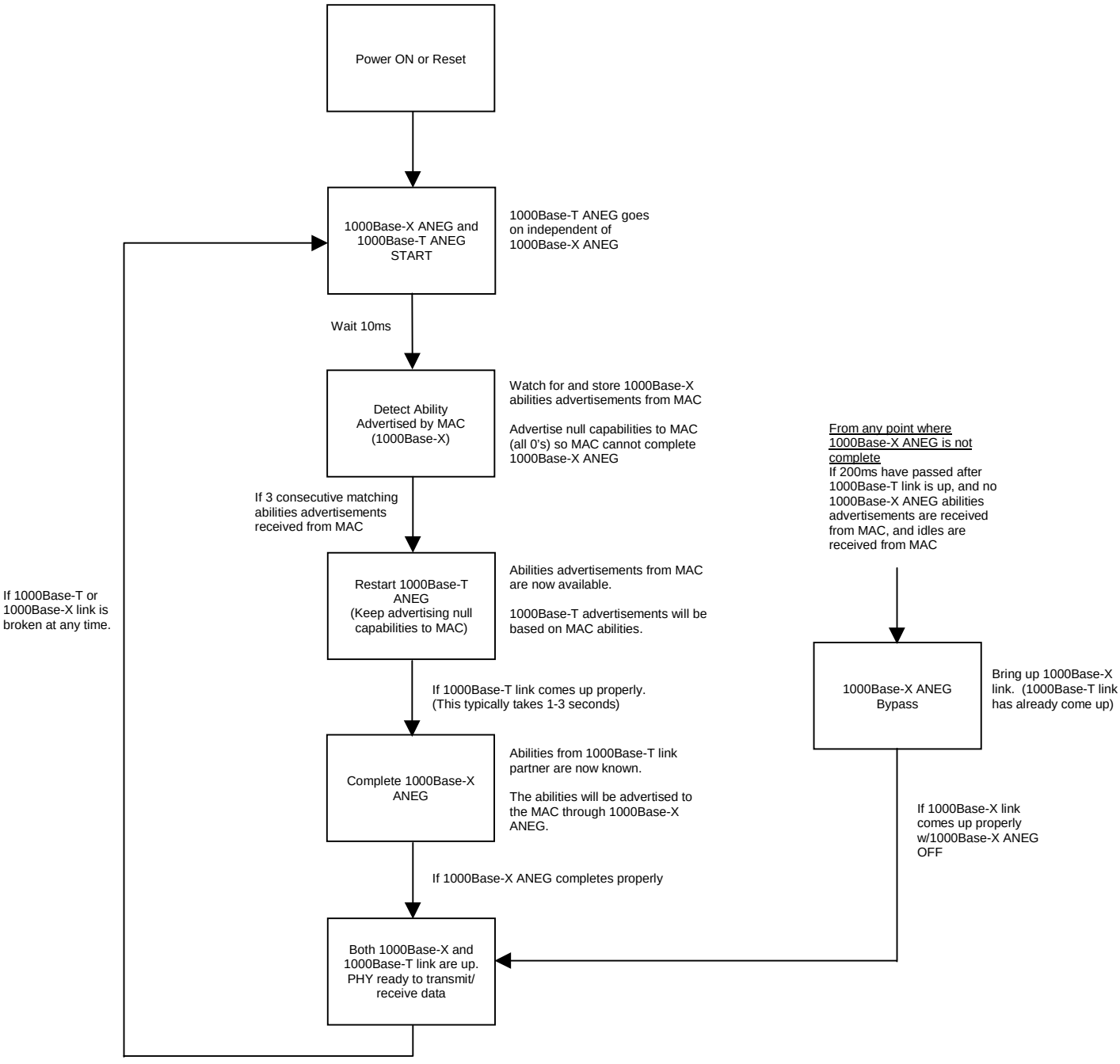
The following diagram describes the SFP auto-negotiation process:



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SFP Auto-Negotiation in real applications
Below are a few cases to show how SFP Auto-Negotiation operation works in an actual application.

Case1: An SFP is inserted into a switch with no copper cable

Regardless of whether the MAC has 1000Base-X Auto-Negotiation turned on or off, 1000Base-X Auto-Negotiation will not complete. As can be seen in the diagram, 1000Base-X Auto-Negotiation will never complete before 1000Base-T link is established.

Case2: After SFP is inserted into a switch w/ 1000Base-X Auto-Negotiation, copper cable is inserted.

SFP will store the 1000Base-X abilities advertisements from the MAC. 1000Base-T Auto-Negotiation will be restarted using abilities advertisements from the MAC. After 1000Base-T link is completed, SFP will send 1000Base-X abilities advertisements and acknowledgement codewords to the MAC. 1000Base-X link will then be established.

Case3: After SFP is inserted into a switch w/ no 1000Base-X Auto-Negotiation, copper cable is inserted.

SFP will detect that only idles are received from the MAC. 1000Base-T link will be established based on abilities set by hardware strap options on the PHY. After 1000Base-T link is established, the SFP will wait for 200ms and go into bypass mode (1000Base-X Auto-Negotiation OFF). 1000Base-X link will then be established. Note that the hardware strap options must be manually set to agree with the capabilities of the MAC since the MAC abilities will not be sent to the 1000Base-T link partner.

Case4: Both 1000Base-T and 1000Base-X link has been established. Copper cable is then unplugged

When the copper cable is unplugged, 1000Base-T link will be broken. This will restart Auto-Negotiation both for 1000Base-X and 1000Base-T as described in the diagram.

Case5: Copper cable is first plugged into the SFP, then SFP with cable is inserted into switch

This case is the same case 2 and 3. If the SFP is powered up with copper cable already plugged in, it will go through the same Auto-Negotiation process.

Case6: SFP is powered up with MAC powered down/inactive

With no active MAC, obviously 1000Base-X Auto-Negotiation/link will not complete. However note that 1000Base-T link will still be established. The abilities advertised will be based on hardware strap options on the 88E1111.

Case7: SFP in a switch is connected to a second SFP in another switch through copper cable

In this case, the 1000Base-T abilities advertised on each side will be based on the abilities of its own MAC. The abilities advertisement sent to the MAC on the 1000Base-X side will be based on the link partner (The other SFP+MAC)'s capabilities. The link partner's capabilities are found from 1000Base-T Auto-Negotiation but the abilities are originally from the link partner's MAC. As far as the 2 MACs are concerned they are establishing 1000Base-X link with another 1000Base-X link partner.

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