## Aukua MGA2510 Tech Note

Capturing Auto Negotiation exchange on an 8b/10b encoded Ethernet line

The following outlines the steps to capture Auto Negotiation exchanges using the MGA2510 L1 Bit Capture Analyzer.

The MGA2510 allows you to trigger your L1 capture based on PCS ordered sets that are outlined in the IEEE 802.3 standard such as the delimiters for Auto Negotiation (AN) information. These ordered sets indicating AN information are outlined in Clause 36 of the standard as /C1/ or K28.5 D21.5 and /C2/ or K28.5 D2.2 – see Table 1 below.

Code	Ordered Set	Number of Code-Groups	Encoding Alternating /C1/ and /C2/			
/C/	Configuration					
/C1/	Configuration 1	4	/K28.5/D21.5/Config_Reg <sup>a</sup>			
/C2/	Configuration 2	4	/K28.5/D2.2/Config_Reg <sup>a</sup>			
/I/	IDLE		Correcting /I1/, Preserving /I2/			
/I1/	IDLE 1	2	/K28.5/D5.6/			
/12/	IDLE 2	2	/K28.5/D16.2/			
	Encapsulation					
/ <b>R</b> /	Carrier_Extend	1	/K23.7/			
/S/	Start_of_Packet	1	/K27.7/			
/T/	End_of_Packet	1	/K29.7/			
/V/	Error_Propagation	1	/K30.7/			
/LI/	LPI		Correcting /LI1/, Preserving /LI2/			
/LI1/	LPI 1	2	/K28.5/D6.5/			
/LI2/	LPI 2	2	/K28.5/D26.4/			

Two data code-groups representing the Config\_Reg value.

Table 1: Ordered Sets - Table 36-3 of IEEE 802.3-2018

These ordered sets alternate with each other where once /C1/ is used, next /C2/ is used and back to /C1/. To capture this sequence, we will be setting our L1 capture trigger to look for /C1/ and leave enough pre-fill buffer to catch /C2/, in case this was the first ordered set in the sequence. Note: capturing on the code K28.5 alone will not be enough, since K28.5 is used extensively in other ordered sets that are very common, such as IDLEs sequences which are transmitted constantly between frames. For this reason, it's critical to trigger based on a full ordered set, and not just on a single code group out of the ordered set.

For the first step we will select the 'Analyzer' Tab when the MGA2510 is in the Inline Analyzer mode – see item #1 in Figure 1 below.



Figure 1: MGA2510 Analyzer Tab

Next, set the analyzer 'Type' to 'L1 Bit Capture with Trigger' – item #2 in Figure 1 above.

Next open the 'Advanced Capture Settings' window by selecting the cog icon as shown in item #3 of Figure 1. It will display the following controls:

Maximum Buffer Size	20	MB		
	1 - 56000			
Maximum File Size	250	MB		
	1 - 5000			
File compression		none 🔻		
Archive compression	zip			
Use pcapng file format?				
Capture 'Event' meta packets?				
PCAP Timestamp Resolution		ns 🔻		
Trigger Buffer Config	13%	87%		
	Prefill	Postf		

Figure 2: MGA2510 Advanced Capture Settings

Make sure you have a large enough maximum buffer size to capture all events as well as enough Prefill buffer to capture a previous /C2/ occurrence in case we trigger on /C1/ which follows a previous /C2/. Then click 'OK'.

Next, click the 'Trigger on..' link shown in item #4 Figure 1.

The 'Trigger Condition for L1 Bit Capture' window will open as shown here:

×
•
•
5

Figure 3: MGA2510 Trigger Condition for L1 Bit Capture

For the triggering 'Event' we will select '8b/10b Codegroup Match'. Select the port you'd like to trigger on (Port 1 or Port 2).

Next we would need to specify the /C1/ ordered set. Select a length of 2 (drop down selector to the left side) and enter the two code groups K28.5 and D21.5 as shown in Figure 3 above. Click 'OK' to accept.

Note: the 'Stop When Full' option shown as item #5 in Figure 1 is ignored for triggered L1 captures.

Finally, select the Port you'd like to capture from – item #6 in Figure 1. If you'd like to capture the AN exchange from both sides, select '1&2'.

Once you are ready, start the capture by pressing the 'Start' button in the 'Analyzer' Tab.

Once the L1 data along with the AN exchange is captured, the 'Capture Buffer' capacity will show the buffer is full at the top right side of the HTML GUI.

At this point, a summary analysis of the captured L1 data is shown in the bottom half of the 'Analyzer' Tab providing a snapshot of the captured ordered sets. This analysis confirms if /C1/ and /C2/ ordered sets were captured as shown here:

	Port Configuration	Inline Analyzer	• Apply	PI RX 0,00%	P1 TX 0.00%	P2 RX 0.00%	P2 TX 0.00%	Capture Buffer 195.0MB/200.0	<b>О С и</b> Омв (97.5%)	
Statistics Generation Filters Ar	nalyzer Jamming Port Config	SMA Ports	Admin	TRIG	IN O T	RIG OUT • START	NTP • STOP	CLK 10MHz	CLK 1PPS • ••• CLEAR STATS	
Type UI Bit Capture with Trigger  Ports Name	Last: T	riggered 11/14/2 Start Stop When	022 5:07:18 PM; E Stop	Abort		Elapsed 00:00:21		Bytes 195,022,080		
1&2 v capture	Unlimited IDLEs hhtmmtss.sss	Full	8b/10b Codegroup Match Port 1 K28.5,021.5 Prefill Buffer Config		Port 1	Download View		Browse	Save to USB Browse USB Files	
Fields	Port 1		Port	2						
/C1/	4,640,469		3,481,1	82						
/C2/	4,639,994		3,481,3	89						
/11/	4		209							
/12/	16,965,052		17,292,0	693						
/LPI1/	1		215							
/LPI2/	16		404							
/R/	5,716		24,63	32						
/S/	591		23,26	8						
/T/	4,158		25,14	n						
NI	4,446,079		27,71	9						
codeword_errors	1,454,815		12,397,9	921						
rd_errors	2,084,540		14,924,5	390						

Figure 4: MGA2510 Analyzer Tab after L1 Bit Capture showing summary analysis data

To display the captured L1 PCS data in parsed human-readable text, press the 'View..' button toward the right side, and a new browser window will open where you can review the captured L1 data as shown in Figure 5 here:

INTERFACE SPEED: ENCODING: PAGE SIZE: START TIME: TRIGGER TIME: TRIGGER: USER TEST NAME:	1000BASE-X 8b/10b 15840 Bytes 2022-11-14T22_01_50.157371936Z 2022-11-14T22_01_50.465051129Z (Page 3033) 8b/10b Codegroup Match on Port 1 [K28.5 D21.5] 'capture'	Lock top view: Compress repeated data: Starting page number: Pages to load:	<b>2</b> 3850 (1 100	to 6,188)
↓ Port 1: Showing pages 3.850 to 3.949	↓ Port 2: Showing	pages 3.850 to 3.949		
50.5515104322 1100000101 1010101010 -K28.5 U21.5	//1/ 50.551601504/ 11000000	00 0000000011 -10VLD +10V	D	
50.551510448Z 1001111001 0110001011 +D00.1 +D00.0	0x20 0x00 50.551601520Z 11000000	00 000000011 -INVLD +INV	D	
50.551510464Z 1100000101 1011010101 -K28.5 +D02.2	/C2/ 50.551601536Z 11000000	00 000000011 - INVLD + INV	D	
50.551510480Z 0110001001 1001110100 -D00.1 -D00.0	0x20 0x00 50.551601552Z 11000000	00 000000011 - INVLD + INV	.D	
50.551510496Z 0011111010 1010101010 +K28.5 D21.5	/C1/ 50.551601568Z 11000000	00 000000011 -INVLD +INV	D	
50.551510512Z 0110001001 1001110100 -D00.1 -D00.0	0x20 0x00 50.551601584Z 11000000	00 000000011 -INVLD +INV	D	
50.551510528Z 0011111010 0100100101 +K28.5 -D02.2	/C2/ 50.551601600Z 11000000	00 000000011 -INVLD +INV	.D	
50.551510544Z 1001111001 0110001011 +D00.1 +D00.0	0x20 0x00 50.551601616Z 11000000	00 0000100011 -INVLD +INV	.D	
50.551510560Z 1100000101 1010101010 -K28.5 D21.5	/C1/ 50.551601632Z 11000100	00 0000100011 -INVLD +INV	.D	
50.551510576Z 1001111001 0110001011 +D00.1 +D00.0	0x20 0x00 50.551601648Z 11000100	00 0000100011 -INVLD +INV	D	
50.551510592Z 1100000101 1011010101 -K28.5 +D02.2	/C2/ 50.551601664Z 11000100	00 0000100011 -INVLD +INV	.D	
50.551510608Z 0110001001 1001110100 -D00.1 -D00.0	0x20 0x00 50.551601680Z 11010100	00 0000100111 -INVLD +INV	.D	
50.551510624Z 0011111010 1010101010 +K28.5 D21.5	/C1/ 50.551601696Z 00111110	10 1000000101 +K28.5 -INV	.D	
50.551510640Z 0110001001 1001110100 -D00.1 -D00.0	0x20 0x00 50.551601712Z 00111110	10 1001000101 +K28.5 -D16	2 /12/	
50.551510656Z 0011111010 0100100101 +K28.5 -D02.2	/C2/ 50.551601728Z 00111110	10 1001000101 +K28.5 -D16	2 /12/	
50.551510672Z 1001111001 0110001011 +D00.1 +D00.0	0x20 0x00 50.551601744Z 00111110	10 1001000101 +K28.5 -D16	2 /12/	
50.551510688Z 1100000101 1010101010 -K28.5 D21.5	/C1/ 50.551601760Z 00111110	10 1001000101 +K28.5 -D16	2 /12/	
50.551510704Z 1001111001 0110001011 +D00.1 +D00.0	0x20 0x00 50.551601776Z 00111110	10 1001000101 +K28.5 -D16	2 /12/	
50.551510720Z 1100000101 1011010101 -K28.5 +D02.2	/C2/ 50.5516017922 00111110	10 1001000101 +K28.5 -D16	2 /12/	
50.551510736Z 0110001001 1001110100 -D00.1 -D00.0	0x20 0x00 50.5516018082 00111110	10 1001000101 +K28.5 -D16	2 /12/	
50.551510/522 0011111010 1010101010 +K28.5 D21.5	/(1/ 50.5516018242 00111110	10 1001000101 +K28.5 -D16	2 /12/	
50.5515107682 0110001001 1001110100 -000.1 -000.0	0X20 0X00 50.5516018402 00111110	10 1001000101 +K28.5 -D16	2 /12/	
50.551510/842 0011111010 0100100101 +K28.5 -D02.2	/(2/ 50.5516018562 00111110	10 1001000101 +K28.5 -D16	2 /12/	
50.5515108002 1001111001 0110001011 +000.1 +000.0	(C1/ 50.5510016/22 00111110	10 1001000101 +K20.5 -D16	2 /12/	
50.5515108327 1001111001 0110001011 ±D00 1 ±D00 0	0x20 0x00 50 5516010047 00111110	10 1001000101 +K20.5 -D16	2 /12/	
50 5515108/87 1100000101 10110001011 +D00.1 +D00.0	//2/ 50 551601007 00111110	10 1001000101 +K20.5 -D16	2 /12/	
50 5515108647 0110001001 1001010101 -R20.5 +D02.2	0x20 0x00 50 5516019202 00111110	10 1001000101 +K28 5 -D16	2 /12/	
50.5515108807 0011111010 1010101010 +K28 5 D21 5	/(1/ 50.5516019502 00111110	10 1001000101 +K28.5 -D16	2 /12/	
50.551510896Z 0110001001 1001110100 -D00.1 -D00.0	0x20 0x00 50.551601968Z 00111110	10 1001000101 +K28.5 -D16	2 /12/	

Figure 5: MGA2510 L1 Bit Capture Viewer

In Figure 5 above, you can note that the peer connected to MGA2510 Port 1 is initiating an Auto Negotiation sequence by sending /C1/ and /C2/ ordered sets towards the peer connected to MGA2510 Port 2.

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www.gch-services.com © 2015-2022 Aukua Systems, Inc. All rights reserved. Two options exist for downloading and saving the L1 capture data:

- 1) You can download the original raw binary L1 capture data as .al1 files from the 'Analyzer' Tab by clicking the 'Download' button.
- 2) In addition, from the Viewer shown in Figure 5 above, you can download the Port 1 or Port 2 parsed text data that is currently in view by clicking the blue '' icon at the top of each data column.

Further Note: the 'Reduce IDLEs' option on the 'Analyzer' Tab only impacts the resulting binary .al1 capture file if downloaded. It does not impact the Viewer feature; meaning all IDLEs are still present in the Viewer. See the MGA2510 User Documentation for further details.

Related features of interest (see other Tech Notes and User Documentation for details):

- Trigger an L1 capture on an input TTL signal coming from external devices such as an oscilloscope, logic analyzer, or even the Device Under Test
- Use the SMA Trig OUT port feature to trigger L1 captures on *multiple* events
- Use the SMA Trig OUT feature to essentially create custom statistics based on detecting user-defined codegroup matches. E.g., statistics that count the number of /C1/ or /C2/ ordered sets received per port
- Synchronize other test equipment to PCS events like /C1/ and /C2/ for time-correlated event analysis