Application Note

Astra™ Machina Foundation Series – UART

Abstract: This document details UART connection to Astra™ Machina Foundation Series evaluation modules containing the SL16xx and SL261x SoCs

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1. Overview

The Astra™ Machina Foundation Series offers evaluation-ready kits that facilitate quick and straightforward prototyping with the Synaptics SL-Series of embedded Linux® and Android™ processors. Featuring a modular design, these kits include interchangeable core compute modules, a standard I/O board, and daughter cards for connectivity, debugging, and various I/O configurations. Additionally, the Astra Machina Foundation Series features UART(x) technology.

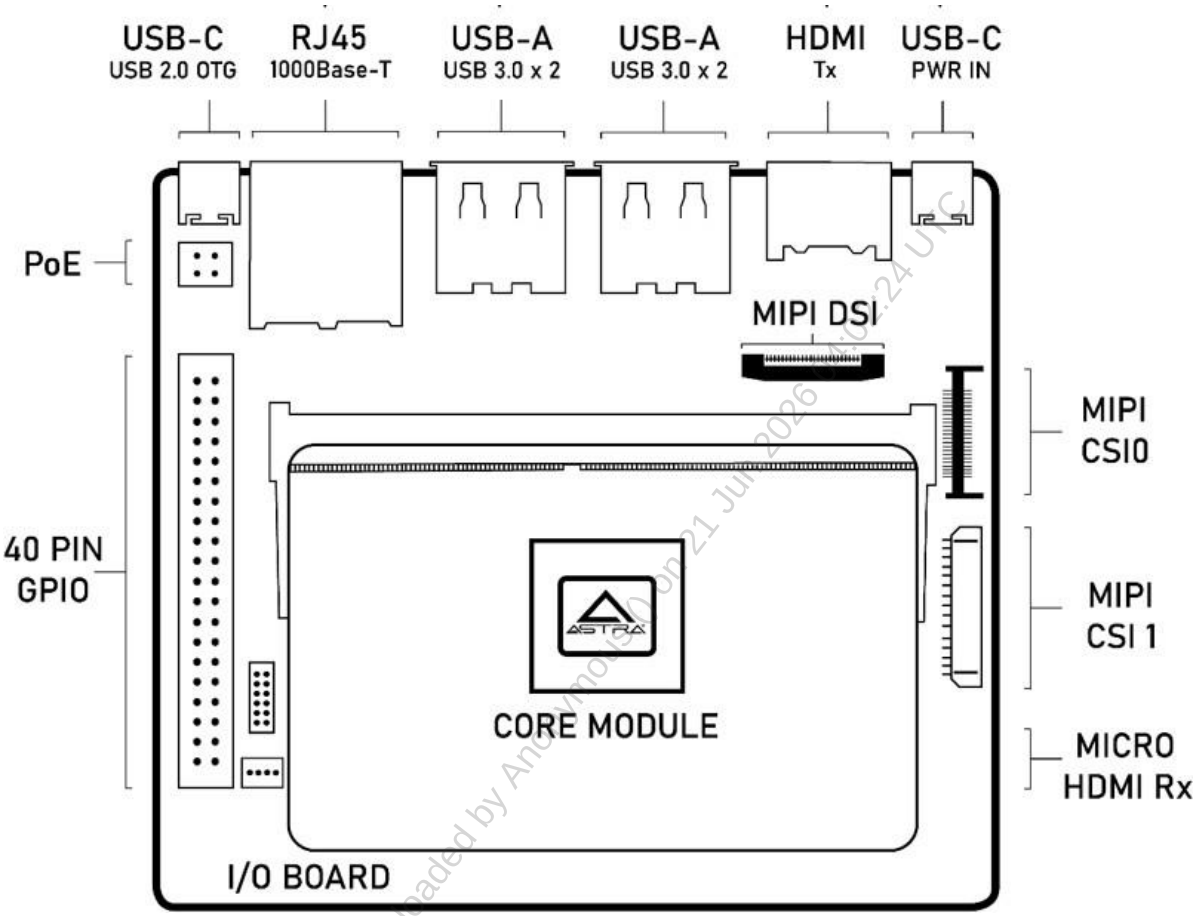

Figure 1. Astra Machina Foundation Series overview

1.1. Scope

This document details UART connection to Astra™ Machina Foundation Series evaluation modules containing the SL16xx series and SL261x SoCs. The supported UART to USB debug/console driver IC are listed.

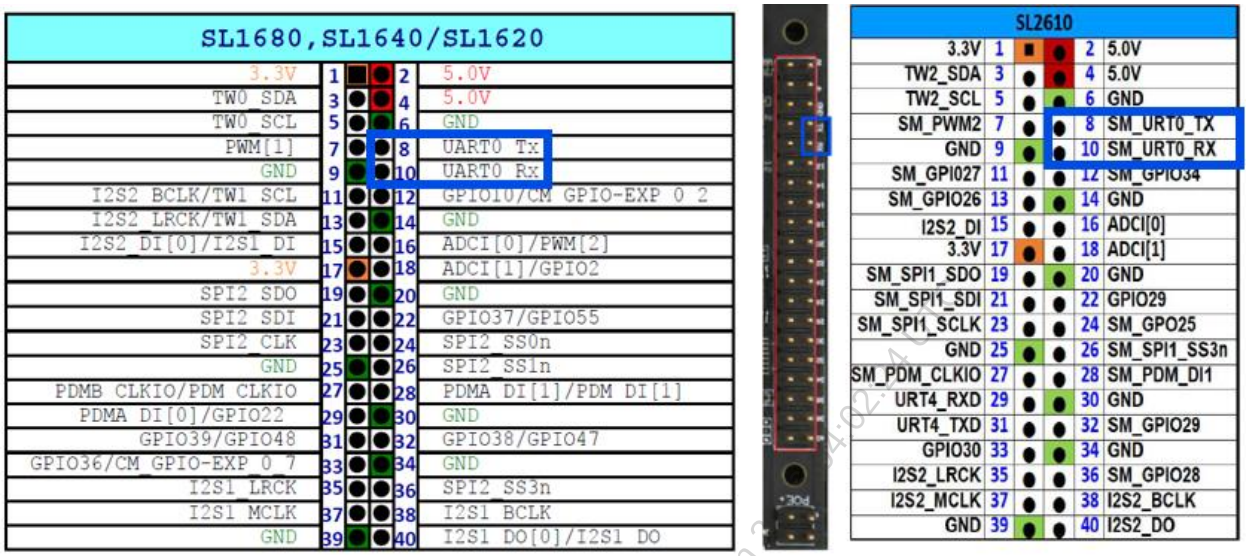

Figure 2. UART pins on 40-pin header (J32) Astra Machina IO board

UART to USB driver modules are connected to *40-pin header (J32) for debug/console*.

Table 1. UART to USB supported Drivers

UART to USB driver modules Pin Function	Astra SL16xx/SL261x RDK 40-pin Connector	Astra SL16xx/SL261x RDK 40-pin Function
5V-Out	NC	NC
TX-Out	Pin-10	UART0_Rx-In
RX-IN	Pin-8	UART0_Tx-Out
GND	Pin-6	GND

Supported UART to USB driver modules:

1. Adafruit USB to UART Debug / Console Cable (CP2102 Driver IC)
   - https://www.digikey.com/en/products/detail/adafruit-industries-llc/954/7064488
   - https://www.adafruit.com/product/954#technical-details
   - https://item.taobao.com/item.htm?_u=e1cfi1qc248&id=37946005623&spm=a1z09.2.0.0.40112e8dTnAnEl&skuId=4878151064465
2. CenryKay USB to UART Debug / Console Cable (CH340G Driver IC)
   - https://www.amazon.com/dp/B09Z2GZ6W4?ref=ppx_yo2ov_dt_b_product_details&th=1

2. UART (x) Introduction

Universal Asynchronous Receiver/Transmitter (UART) is a peripheral device for asynchronous serial communication in which the data format and transmission speeds are configurable.

2.1. UART (x) Timing

Table 2. UART to USB supported Drivers

Parameter	Condition	Typ1	Units
TX bit width	±5%	8.68	µs
RX bit width	±5%	8.68	µs

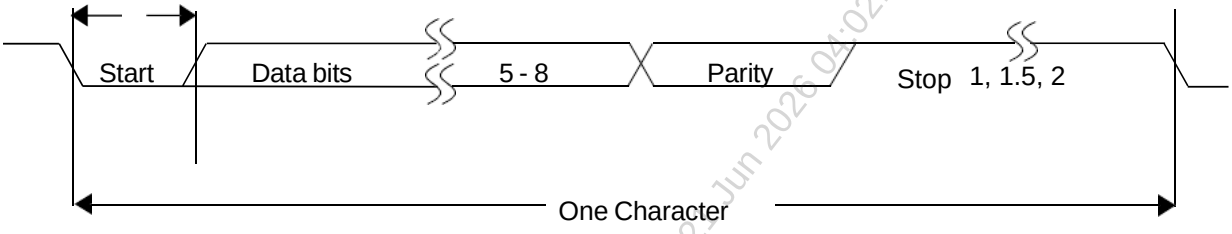

Figure 3. Serial Data Format

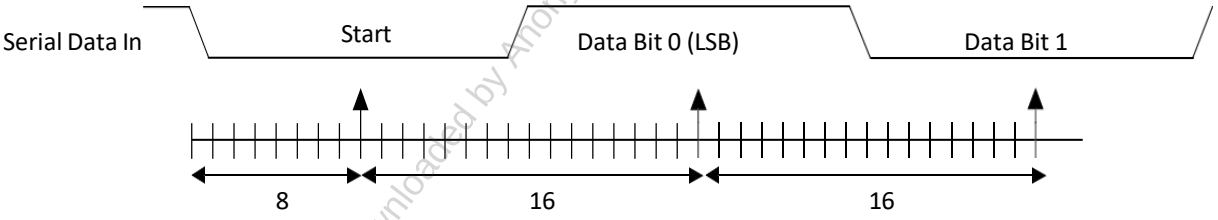

Figure 4. Receiver Serial Data Sample Points

2.2. SL16xx and SL261x UART(x) Baud Rate

SL16xx/SL261x Series UART Interface support various Baud Rates. However, SL16xx/ SL261x Series application set and verified at 115.2K Baud.

Table 3. SL261x and SL16xx UART block Clock Source

UART(x)	SL1680 Clk source
SM_UART(0)	25 MHz
SM_UART(1)	25 MHz
SOC_UART(2)	100 MHz
SOC_UART(3)	100 MHz

UART(x)	SL1640 Clk source
SM_UART(0)	25 MHz
SM_UART(1)	25 MHz
SOC_UART(2)	100 MHz

UART(x)	SL1620 Clk source
SOC_UART(1)	100 MHz
SOC_UART(2)	100 MHz

UART(x)	SL261x Clk source
SM_UART(0)	25 MHz
SM_UART(1)	100 MHz
SM_UART(2)	100 MHz
SM_UART(3)	100 MHz
SOC_UART(4)	100 MHz
SOC_UART(5)	100 MHz
SOC_UART(6)	100 MHz
SOC_UART(7)	100 MHz

2.2.1. Baud Rate Calculation

Divider Mechanism:

To achieve high accuracy and minimal baud deviation, the UART uses a combined integer and fractional divider system. This mechanism allows precise baud generation from reference clocks,

The baud rate clock is calculated as:

$$F_{OUT} = \frac{F_{CLK\_IN}}{16 \times (\text{Integer} + \frac{\text{Frac}}{16})}$$

Where:

- F_OUT is the desired baud rate,
- F_CLK_IN is the input clock frequency,
- Integer is the integer divider (from DLL and DLH),
- Frac is the 4-bit fractional component (from DLF).

Formula to Calculate Dividers

Given a target baud rate:

$$\text{Integer} = \text{Int}\left(\frac{F_{\text{CLK\_IN}}}{16 \times \text{BaudRate}}\right)$$

$$\text{Frac} = \text{Round}\left(16 \times \left(\frac{F_{\text{CLK\_IN}}}{16 \times \text{BaudRate}} - \text{Integer}\right)\right)$$

Constraints

- Integer divider must be greater than 2
- Frac must be non-zero
- The resulting baud rate deviation should be < 2%, to meet UART standards.

Table 4. UART Baud Rate Configuration Registers

Register	Offset	Field	Description
DLL	0x00	[7:0]	Divisor Latch Low (Integer part LSB)
DLH	0x04	[7:0]	Divisor Latch High (Integer part MSB)
DLF	0xC0	[3:0]	Divisor Latch Fraction (4-bit Frac)
LCR	0x0C	[7] DLAB	Divisor Latch Access Bit (enable DLL/DLH access)

3. SL16xx and SL261x UART Pinmux

Following are the SL261x and SL16xx UART Pinmux tables.

Table 5. SL1680 UART Pinmux

Pin #	Mode 0	Mode 1	Mode 2	Mode 4	Mode 5	Mode 6	Mode 7
AW51	SM_URT0_RXD	—	—	—	—	—	—
AW55	SM_URT0_TXD	—	—	—	—	—	—
AY59	—	—	—	—	—	—	SM_URT1_CTSn
AR55	—	—	—	—	—	M_URT1_RTSn	—
AB60	—	SM_URT1_RXD	—	—	—	—	—
AG59	—	SM_URT1_TXD	—	—	—	—	—
AT59	—	—	—	—	URT2_TXD	—	—
AY59	—	—	—	—	URT2_RXD	—	—
AY60	—	—	URT2_RTSn	—	—	—	—
AY57	—	—	URT2_CTSn	—	—	—	—
W47	—	—	—	URT3_RXD	—	—	—
R51	—	—	—	URT3_TXD	—	—	—
W49	—	—	—	URT3_CTSn	—	—	—
R53	—	—	—	URT3_RTSn	—	—	—

Table 6. SL1640 UART Pinmux

Pin #	Mode 0	Mode 1	Mode 2	Mode 4	Mode 5	Mode 6	Mode 7
AL28	SM_URT0_TXD	—	—	—	—	—	—
AK28	SM_URT0_RXD	—	—	—	—	—	—
AC32	—	SM_URT1_TXD	—	—	—	—	—
AD31	—	SM_URT1_RXD	—	—	—	—	—
AK31	—	—	—	—	—	SM_URT1_RTSn	—
AL30	—	—	—	—	—	—	SM_URT1_CTSn
AK32	—	—	—	—	URT2A_TXD	—	—
AL30	—	—	—	—	URT2A_RXD	—	—
AN30	—	—	URT2A_RTSn	—	—	—	—
AL29	—	—	URT2A_CTSn	—	—	—	—
B5	—	—	—	URT2B_RXD	—	—	—
B6	—	—	—	URT2B_TXD	—	—	—
B7	—	—	—	URT2B_CTSn	—	—	—
A8	—	—	—	URT2B_RTSn	—	—	—

Table 7. SL1620 UART Pinmux

Pin #	Mode 0	Mode 2	Mode 3
F14	URTOA_RXD	—	—
B15	URTOA_TXD	—	—
A8	—	URTOA_CTSn	—
B8	—	URTOA_RTSn	—
B13	—	URTOB_RXD	—
C12	—	URTOB_TXD	—
N31	—	URTOB_CTSn	—
P27	—	URTOB_RTSn	—
C22	—	URT1A_RXD	—
C23	—	URT1A_TXD	—
B21	—	URT1A_RTSn	—
C21	—	URT1A_CTSn	—
B25	—	—	URT1B_TXD
B26	—	—	URT1B_RXD
C26	—	—	URT1B_RTSn
C27	—	—	URT1B_CTSn

Table 8. SL261x UART Pinmux

Pin #	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7
V30	—	SM_URT0_TXD	—	—	—	—	—
T30	—	SM_URT0_RXD	—	—	—	—	—
T31	SM_URT0_RXD	—	—	—	—	SM_URT1_RXD	—
U26	SM_URT0_TXD	—	—	—	—	SM_URT1_TXD	—
P29	—	SM_URT0_CTSn	—	—	—	SM_URT1_CTSn	—
P30	—	SM_URT0_RTSn	—	—	—	SM_URT1_RTSn	—
R29	SM_URT1_RXD	—	—	—	—	SM_URT0_RXD	—
N30	SM_URT1_TXD	—	—	—	—	SM_URT0_TXD	—
L29	—	SM_URT2_TXD	—	SM_URT3_RTSn	SM_URT3_DE	—	—
K29	—	SM_URT2_RXD	—	SM_URT3_CTSn	SM_URT3_REn	—	—
J29	—	SM_URT3_TXD	—	SM_URT2_RTSn	SM_URT0_RTSn	—	SM_URT1_RTSn
H30	—	SM_URT3_RXD	—	SM_URT2_CTSn	SM_URT0_CTSn	—	SM_URT1_CTSn
F19	—	SM_URT1_RXD	—	—	SM_URT0_RXD	—	—
A21	—	SM_URT1_TXD	—	—	SM_URT0_TXD	—	—
B21	—	—	SM_URT2_TXD	SM_URT3_RTSn	—	SM_URT3_DE	—
C21	—	—	SM_URT2_RXD	SM_URT3_CTSn	—	SM_URT3_REn	—
F21	—	SM_URT1_RTSn	SM_URT3_TXD	SM_URT2_RTSn	—	SM_URT0_RTSn	—
C22	—	SM_URT1_CTSn	SM_URT3_RXD	SM_URT2_CTSn	—	SM_URT0_CTSn	—
C6	URT5_RXD	—	—	SM_URT1_RXD	—	—	—
C5	URT5_TXD	—	—	SM_URT1_TXD	—	—	—
A3	—	URT4_TXD	—	SM_URT1_RTSn	—	—	—
B2	—	URT4_RXD	—	SM_URT1_CTSn	—	—	—
A6	—	URT4_DE	—	SM_URT1_RXD	—	—	—
B6	—	URT4_Ren	—	SM_URT1_TXD	—	—	—
C9	—	—	—	URT5_RXD	—	—	—
B9	—	—	—	URT5_TXD	—	—	—
D11	—	—	—	URT6_RXD	—	—	—
A9	—	—	—	URT6_TXD	—	—	—
B12	—	—	—	URT7_RXD	—	—	—
C13	—	—	—	URT7_TXD	—	—	—
C14	—	—	—	—	SM_URT1_RTSn	—	—
B14	—	—	—	—	SM_URT1_CTSn	—	—

4. SL16xx and SL261x UART Program Flow

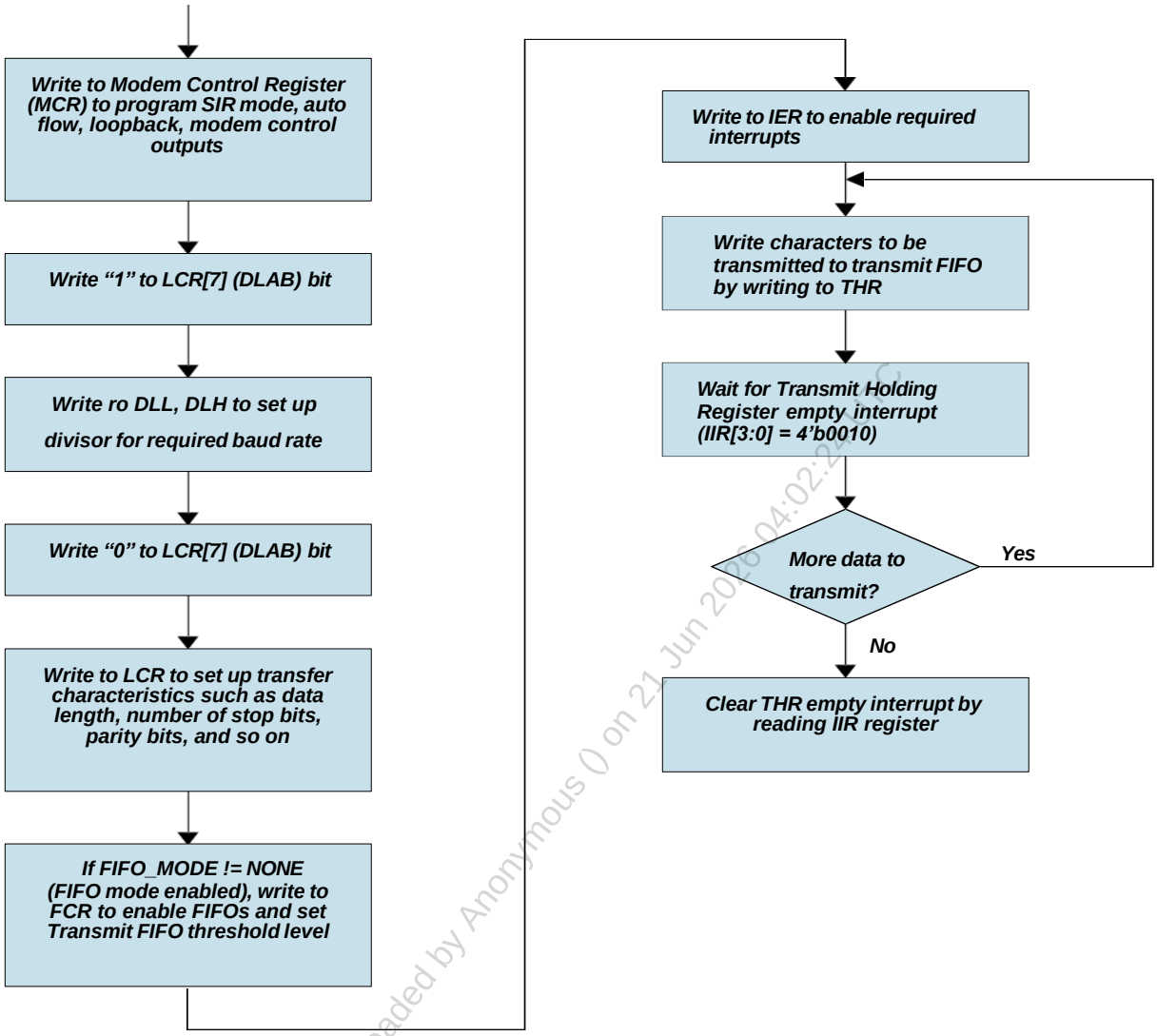

Figure 5. Flowchart UART Transmit Programming Example

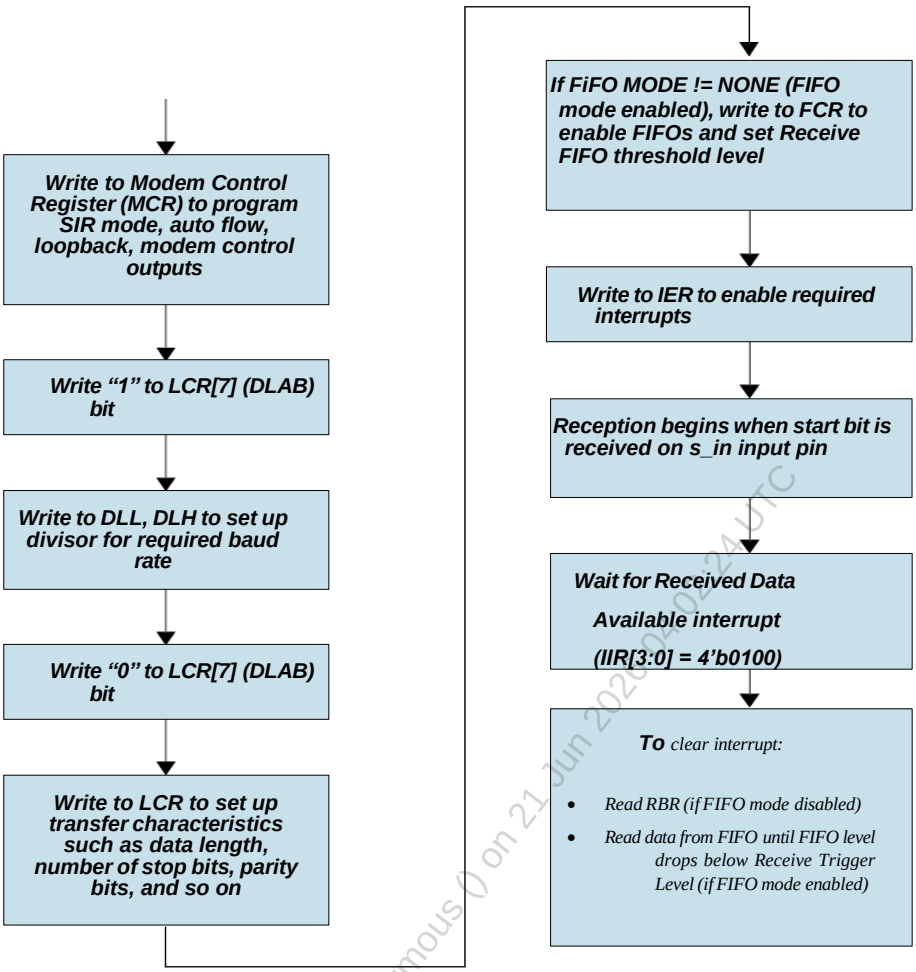

Figure 6. Flowchart UART Receive Programming Example

5. References

- *Astra Machina Foundation Series Quick Start Guide* (PN: 511-001404-01)
- *Astra Machina SL1640 Developer Kit User Guide* (PN: 511-001405-01)
- *Astra Machina SL1620 Developer Kit User Guide* (PN: 511-001407-01)
- *Astra Machina SL1680 Developer Kit User Guide* (PN: 511-001403-01)
- *Astra Machina SL2600 Series Developer Kit User Guide* (PN: 511-001453-01)

6. Revision History

Revision	Description
A	Initial release.
B	Updated Pinmux Table
C	Added SL261x information.

Contact Us

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PN: 506-001506-01 Rev C