january 2018, februari 2020

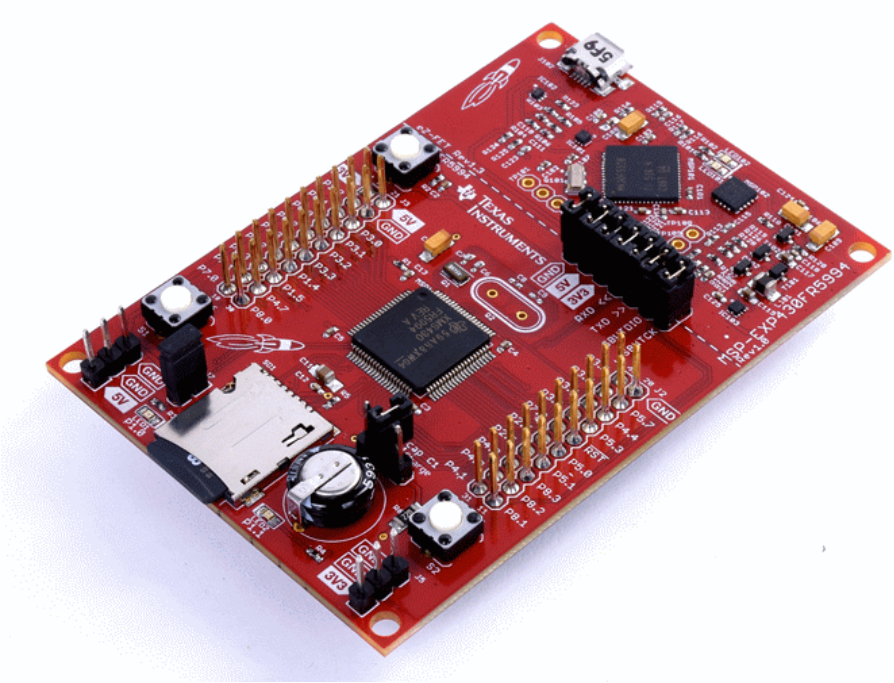
noForth website

MSP-EXP430FR5994 with noForth 5994

In this text we refer to these two documents:

- MSP430FR5994.PDF "MSP430FR599x, MSP430FR596x mixed signal microcontroller"
- SLAU367O.PDF "MSP430FR58xx, FR59xx, FR6xx Family User's Guide"

1. MSP-EXP430FR5994 with noForth 5994



MSP-EXP430FR5994 LaunchPad
Core Sub-Architecture: MSP430X
Kit Contents: LaunchPad Emulator, Mini USB-B Cable, Quick Start Guide

- Farnell - Ordercode: 2664588, TEXAS INSTRUMENTS - MSP-EXP430FR5994
- Aliexpress - https://nl.aliexpress.com/item/MSP-EXP430FR5994-MSP430FR5994-LaunchPad-development-kit-original/32814924502.html

i/o port connections on MSP-EXP430FR5994

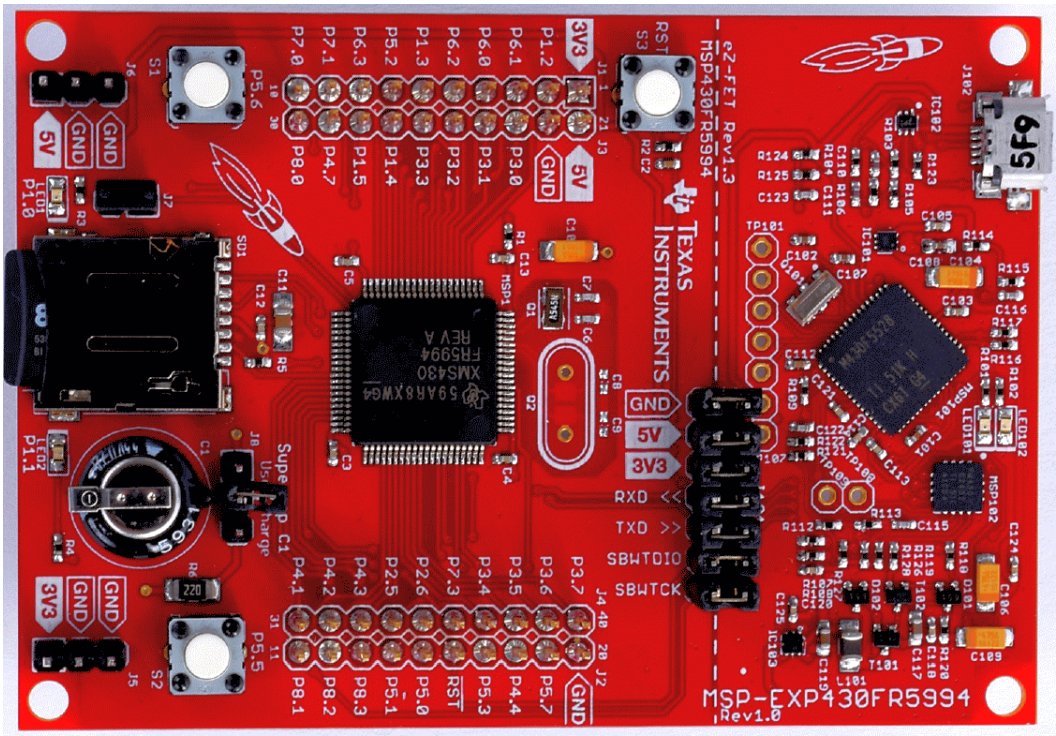
```
Port 1              Port 4
P1.0  - Led 1       P4.0  - SD CS
P1.1  - Led 2       P4.1  - ...
P1.2  - ...         P4.2  - ...     Port 7
P1.3  - ...         P4.3  - ...     P7.0  - ...
P1.4  - ...         P4.4  - ...     P7.1  - ...
P1.5  - ...         P4.5  - ...     P7.2  - SD Select
P1.6  - SD Mosi     P4.6  - ...     P7.3  - ...
P1.7  - SD Miso     P4.7  - ...     P7.4  - ...
                                    P7.5  - ...
Port 2              Port 5          P7.6  - ...
P2.0  - RX<<        P5.0  - ...     P7.7  - ...
P2.1  - TX>>        P5.1  - ...
P2.2  - SD Clk      P5.2  - XINB
P2.3  - ...         P5.3  - XOUTB
P2.4  - ...         P5.4  - ...
P2.5  - ...         P5.5  - S2
P2.6  - ...         P5.6  - S1
P2.7  - ...         P5.7  - ...
```

Connectors on MSP-EXP430FR5994

```
J1,J3  = i/o P1, P3, P4 P4, P6, P7, 3V3, 5V, GND
J2,J4  = i/o P2, P3, P4, P5, P7, RST, Etc.
J101   = Programmer connection and USB RS232
J3     = JTAG connector
J6     = External power (3,6V tot 5V)
J102   = USB RS232 and programmer interface
J8     = Power select/Charge
```

Hardware on MSP-EXP430FR5994

- Two leds on P1.0 and P1.1
- Switch S1 on P5.6
- Switch S2 on P5.5
- Super capacitor of 0.1 Farad
- Reset switch S3 (RST)
- Micro SD card



2. MSP430FR5994 i/o ports

Addresses

The MSP430FR5994 port registers are memory mapped. An overview:

Label	P1	P2	P3	P4	P5	P6	P7	P8	PJ	Function
PxIN	200	201	220	221	240	241	260	261	320	Input
PxOUT	202	203	222	223	242	243	262	263	322	Output
PxDIR	204	205	224	225	244	245	264	265	324	Direction
PxREN	206	207	226	227	246	247	266	267	326	Resistor enable
PxSEL0	20A	20B	22A	22B	24A	24B	26A	26B	32A	Select 0
PxSEL1	20C	20D	22C	22D	24C	24D	26C	26D	32C	Select 1
PxIV	20E	21E	22E	22F	24E	25E	26E	27E		Interrupt vector word
PxSELC	210	211	230	231	256	257	276	277	336	Complement selection
PxIES	218	219	238	239	258	259	278	279		Interrupt edge select
PxIE	21A	21B	23A	23B	25A	25B	27A	27B		Interrupt on
PxIFG	21C	21D	23C	23D	25C	25D	27C	27D		Interrupt flag

PxDir, PxREN and PxOUT

The three registers PxDIR, PxREN and PxOUT are used to configure an i/o pin:

PxDIR	PxREN	PxOUT	Pin configuration
0	0	x	Floating input
0	1	0	Input with resistor to GND
0	1	1	Input with resistor to VCC
1	x	x	Output

More info in SLAU367O.PDF page 365.
Texas Instruments recommends to configure unconnected i/o pins as Output.

PxSEL0 and PxSEL1

The registers PxSEL0 and PxSEL1 are used to assign a special function to an i/o pin. In this way, for example, the ADC of UART can be activated. See MSP430FR5994.PDF page 85-122.

PxSEL1	PxSEL0	i/o-function
0	0	Normal i/o
0	1	Basic extra function
1	0	Controller specific!
1	1	Second extra function

RS232/USB driver

The Windows USB-driver for this board is: ezFET-Lite-Driver1.zip. Extract and install it.
If by accident Windows does not install the correct driver, you have to install the MSP Flasher from Texas Instruments and run it once. Follow the directions and the MSP Flasher will install the correct driver for you.
The eUSCI A0 is used as UART. Pins P2.0 (TX>>) and P2.1 (RX<<) are used, the default baudrate is 115200 baud.

3. RAM and ROM

```
RAM 1C00 - 3BFF,  ROM (FRAM) 4000 - 43FFF
```

4. MSP430FR5994 interrupt vector table

```
FF7E  - End of free flash
FF80  - JTAG signature
FF84  - BSL signature
FFB4  - LEA
FFB6  - P8                          FFE0  - TIMER A1 CCR1 CCR2
FFB8  - P7                          FFE2  - TIMER A1 CCR0
FFBA  - USCI B3 RX/TX               FFE4  - DMA
FFBC  - USCI B2 RX/TX               FFE6  - USCI A1 RX/TX
FFBE  - USCI B1 RX/TX               FFE8  - TIMER A0 CCR1 CCR2
FFC0  - USCI A3 RX/TX               FFEA  - TIMER A0 CCR0
FFC2  - USCI A2 RX/TX               FFEC  - ADC12
FFC4  - P6                          FFEE  - USCI B0 RX/TX
FFC6  - P5                          FFF0  - USCI A0 RX/TX
FFC8  - TIMER A4 CCR1               FFF2  - WATCHDOG
FFCA  - TIMER A4 CCR0               FFF4  - TIMER B0 CCR1 to CCR6
FFCC  - AES                         FFF6  - TIMER B0 CCR0
FFCE  - RTC                         FFF8  - COMPARATOR
FFD0  - P4                          FFFA  - NMI USER
FFD2  - P3                          FFFC  - NMI SYSTEM
FFD4  - TIMER A3 CCR1               FFFE  - RESET (from many sources)
FFD6  - TIMER A3 CCR0
FFD8  - P2
FFDA  - TIMER A2 CCR1
FFDC  - TIMER A2 CCR0
FFDE  - P1
```

See MSP430FR5994.PDF page 69-71 for details.

5. Processor registers in noForth

All processor registers (R0..R15) have their own name in noForth assembler:

`PC  RP (SP in TI texts!) SR CG`	MSP430 system registers
`SP  IP  TOS  DOX  NXT`	noForth system registers
`W   DAY SUN  MOON`	Registers, locally used by noForth
`XX  YY  ZZ`	Unused (free) registers