

(jan 2018)



[noForth website](#)

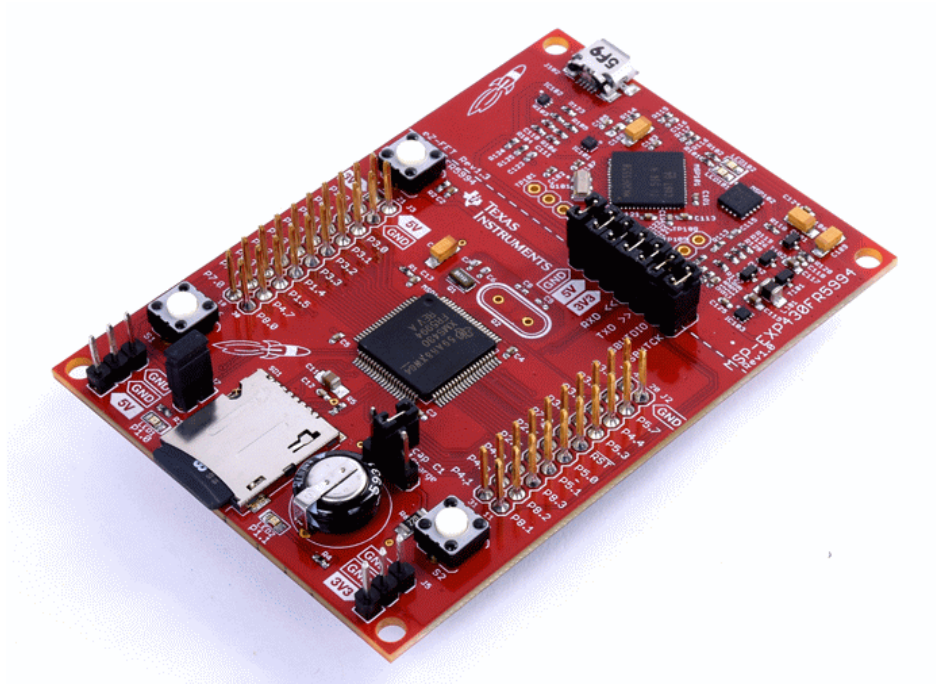
MSP-EXP430fr5994 Experimenter Board with noForth 5994

1. MSP-EXP430fr5994 Experimenter Board with noForth 5994
 - i/o port connections on Experimenter Board
 - Connectors on Experimenter Board
 - Hardware on Experimenter Board
2. MSP430fr5994 i/o Ports
 - Port addresses
 - PxDir, PxREN and PxOUT
 - PxSel
 - RS232/USB driver
3. MSP430fr5994 RAM & ROM
4. MSP430fr5994 interrupt vector table
5. Processor registers in noForth

In this text we refer to these two documents:

- SLASE54.PDF "MSP430FR599x, MSP430FR596x mixed signal microcontroller"
- SLAU367O.PDF "MSP430FR58xx, FR59xx, FR6xx Family User's Guide"

1. MSP-EXP430fr5994 Experimenter Board with noForth 5994



MSP430fr5994 Experimenters board

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 Experimenter Board

Port 1

P1.0 - Led 1
P1.1 - Led 2
P1.2 - ...
P1.3 - ...
P1.4 - ...
P1.5 - ...
P1.6 - SD Mosi
P1.7 - SD Miso

Port 2

P2.0 - RX
P2.1 - TX
P2.2 - SD Clk
P2.3 - ...
P2.4 - ...
P2.5 - ...
P2.6 - ...
P2.7 - ...

Port 4

P4.0 - SD CS
P4.1 - ...
P4.2 - ...
P4.3 - ...
P4.4 - ...
P4.5 - ...
P4.6 - ...
P4.7 - ...

Port 5

P5.0 - ...
P5.1 - ...
P5.2 - XINB
P5.3 - XOUTB
P5.4 - ...
P5.5 - S2
P5.6 - S1
P5.7 - ...

Port 7

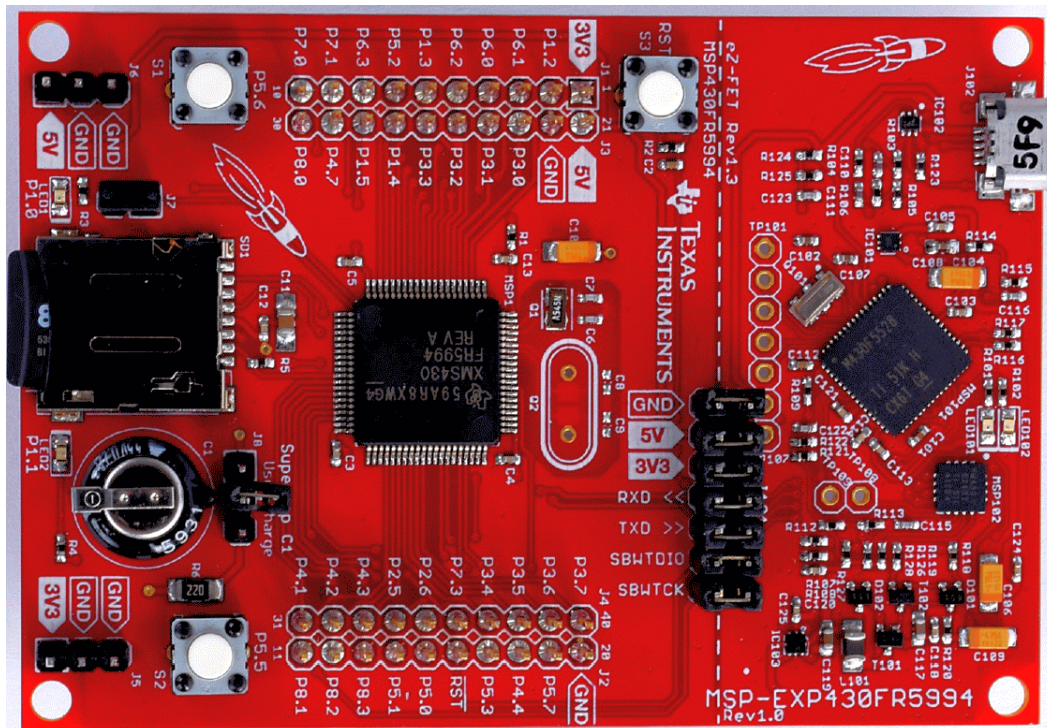
P7.0 - ...
P7.1 - ...
P7.2 - SD Select
P7.3 - ...
P7.4 - ...
P7.5 - ...
P7.6 - ...
P7.7 - ...

Connectors on Experimenter Board

- J1, J3 = i/o P1, P3, 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 Experimenter Board

- 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
P1IV	20E	21E	22E	22F	24E	25E	26E	27E		Interrupt vector word
P1SELC	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.

PxSEL and PxSEL2

The registers PxSEL and PxSEL2 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 SLASE54.PDF page 83-120.

PxSEL2	PxSEL	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 SLASE54.PDF page 67-69 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