

# 电机控制板硬件方案（部分）实例讲解

- 基于TLF35584的TC275电源方案设计
- 基于TC275的RDC软解码所需的硬件电路简介

李超 – 英飞凌 北京汽车系统工程部(IFBJ ATV SYS)

2015-07



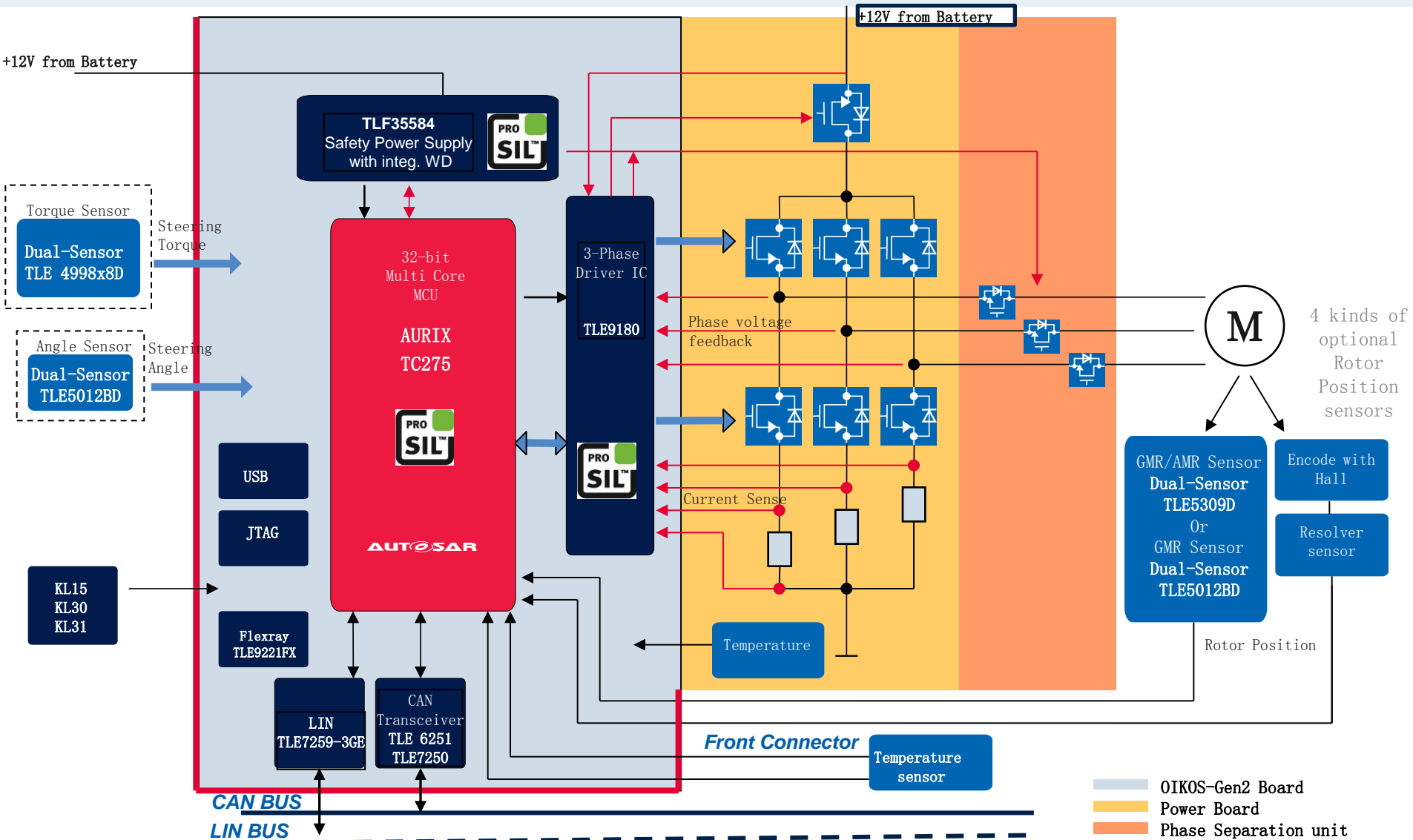
# 内容概要

- OIKOS-Gen2开发板简介
- 基于TLF35584的TC275电源方案设计实例
  - TC275需要什么电源供电
  - TC275内部能提供什么电源
  - TLF35584能提供什么电源
  - OIKOS-Gen2开发板电源方案及原理图
- 基于TC275的RDC软解码所需的硬件电路简介
  - RDC解码原理简介
  - OIKOS-Gen2开发板RDC软解码所需的硬件电路

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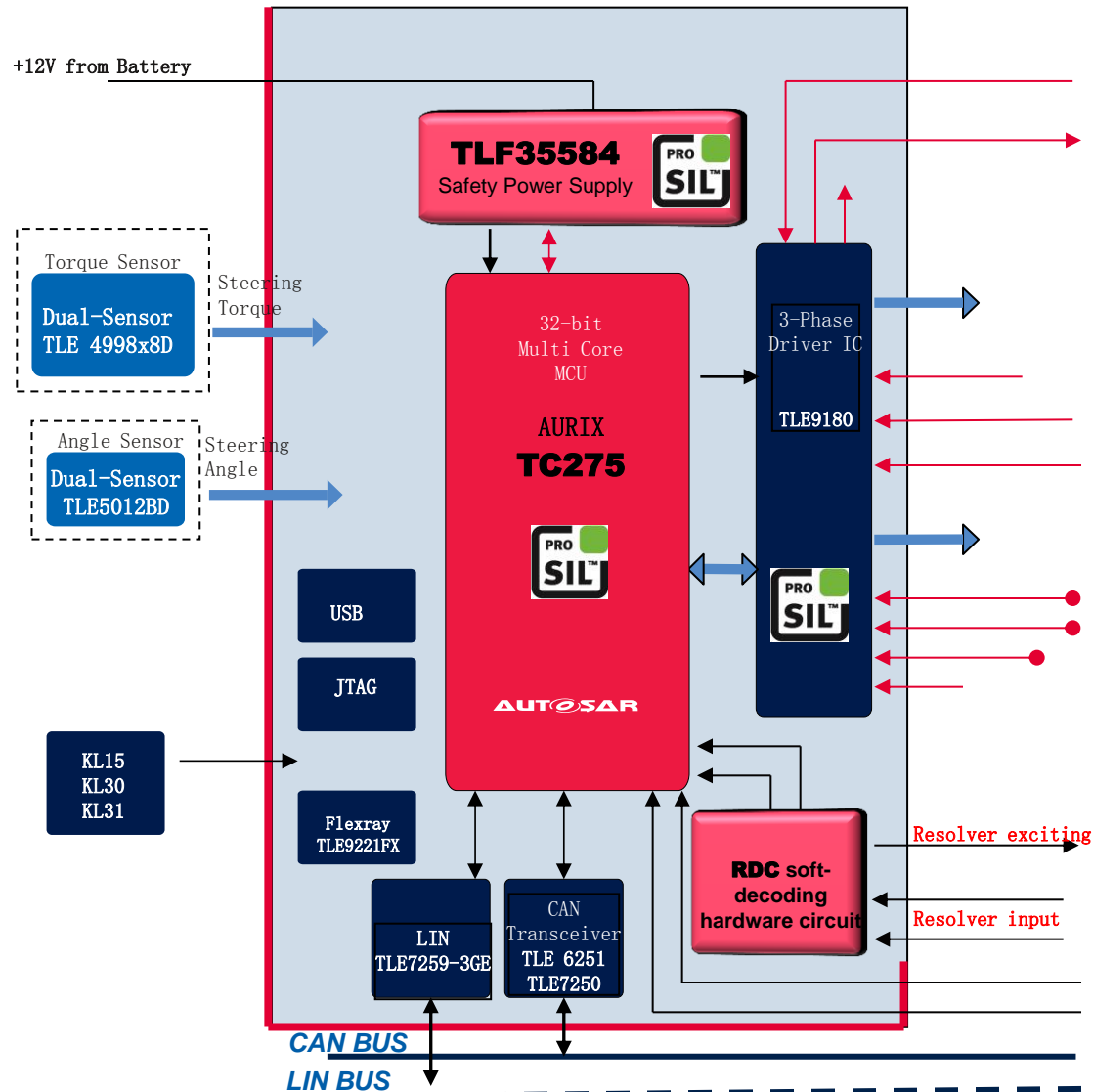
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# OIKOS-Gen2开发平台



# OIKOS-Gen2开发板

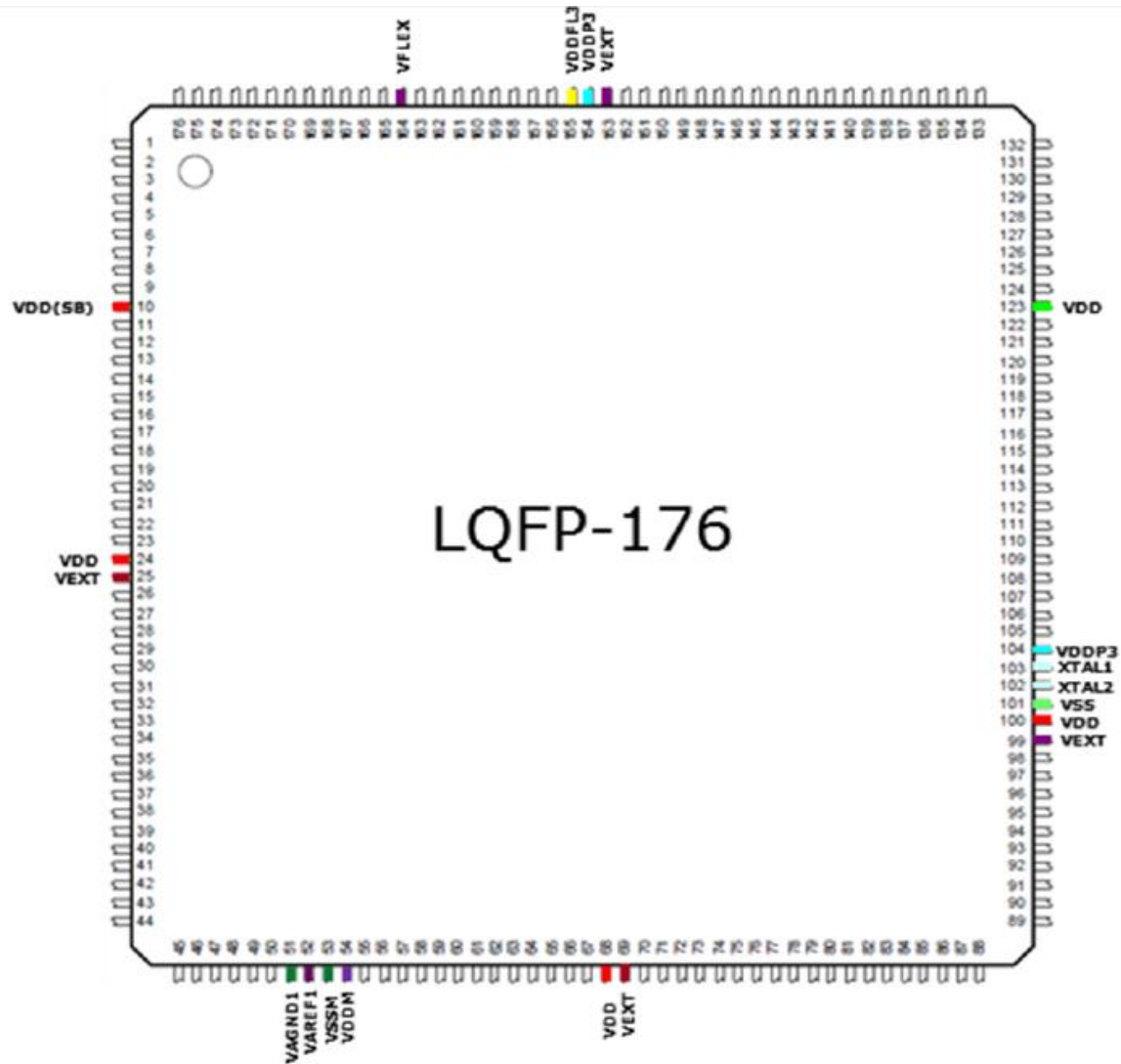
- EPS开发板
- 驱动永磁同步电机 (PMSM)
- 主要器件
  - 多路输出单机电源芯片 TLF35584
  - AURIX™ 单片机 TC275
  - ...
- 电机转子位置传感器接口
  - 旋转变压器
  - ...



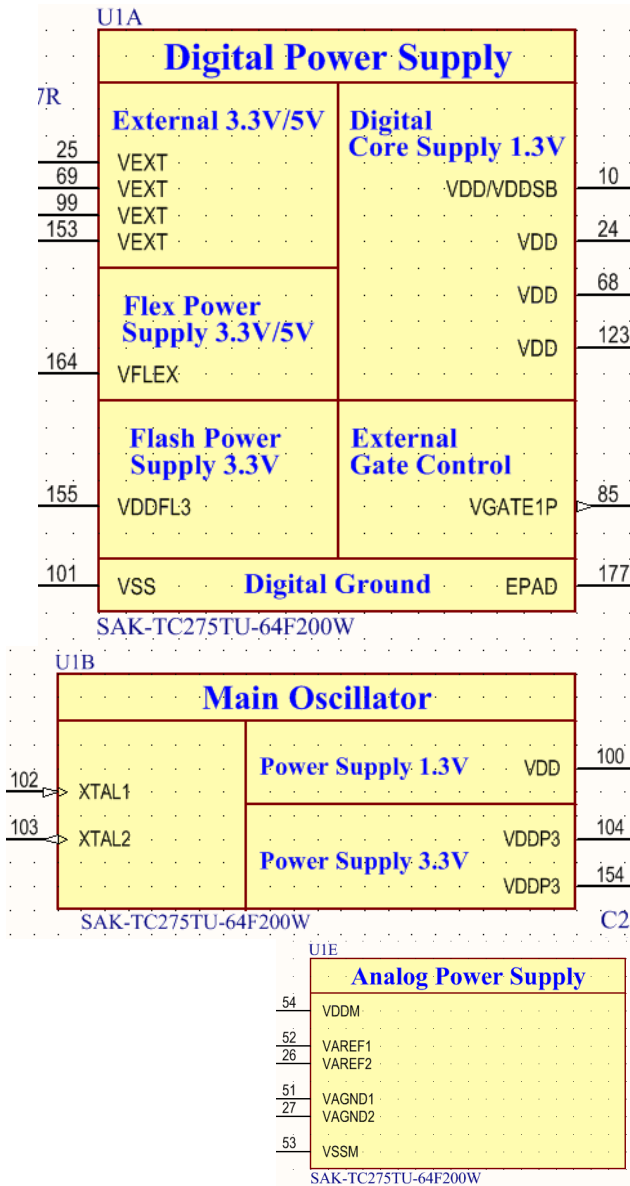
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# TC275的供电管脚



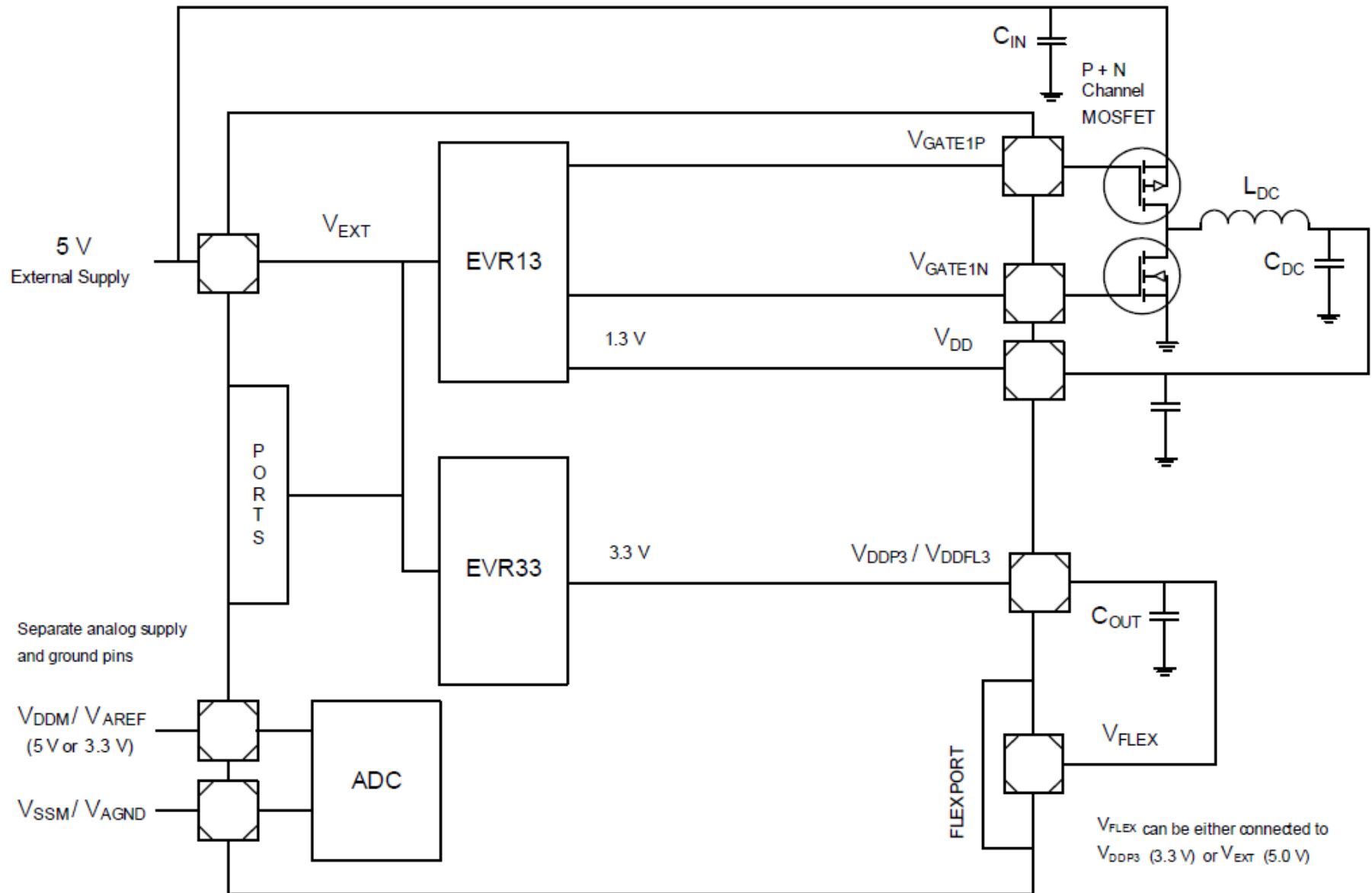
# TC275所需的供电










Power supply symbol	Voltage (v)	Main function
VEXT	5 or 3.3	External Power Supply; Source voltage for internal EVR13 & EVR33 regulators if the EVR33 or EVR13 is used; Main I/O power supply which decides the I/O logic level;
VFLEX	5 or 3.3	Power supply for Flex Port pads which decides the I/O logic level of Port 11.
VDDFL3	3.3	Flash sense amplifier power supply
VDDP3	3.3	Flash, JTAG & Port 21 power supply; Oscillator and PLL power supply;
VDD	1.3	Digital Core Power Supply
VSS	0	Digital Ground
EPAD	0	Exposed pad, Digital Ground
VDDM	5 or 3.3	Main ADC power supply
VSSM	0	Analog Ground of the VDDM
VAREF1	5 or 3.3	ADC Reference 1 power supply
VAGND1	0	Analog Ground of the VAREF1
VAREF2	5 or 3.3	ADC Reference 2 power supply
VAGND2	0	Analog Ground of the VAREF2



# TC275内部集成的EVR(Embedded Voltage Regulator)

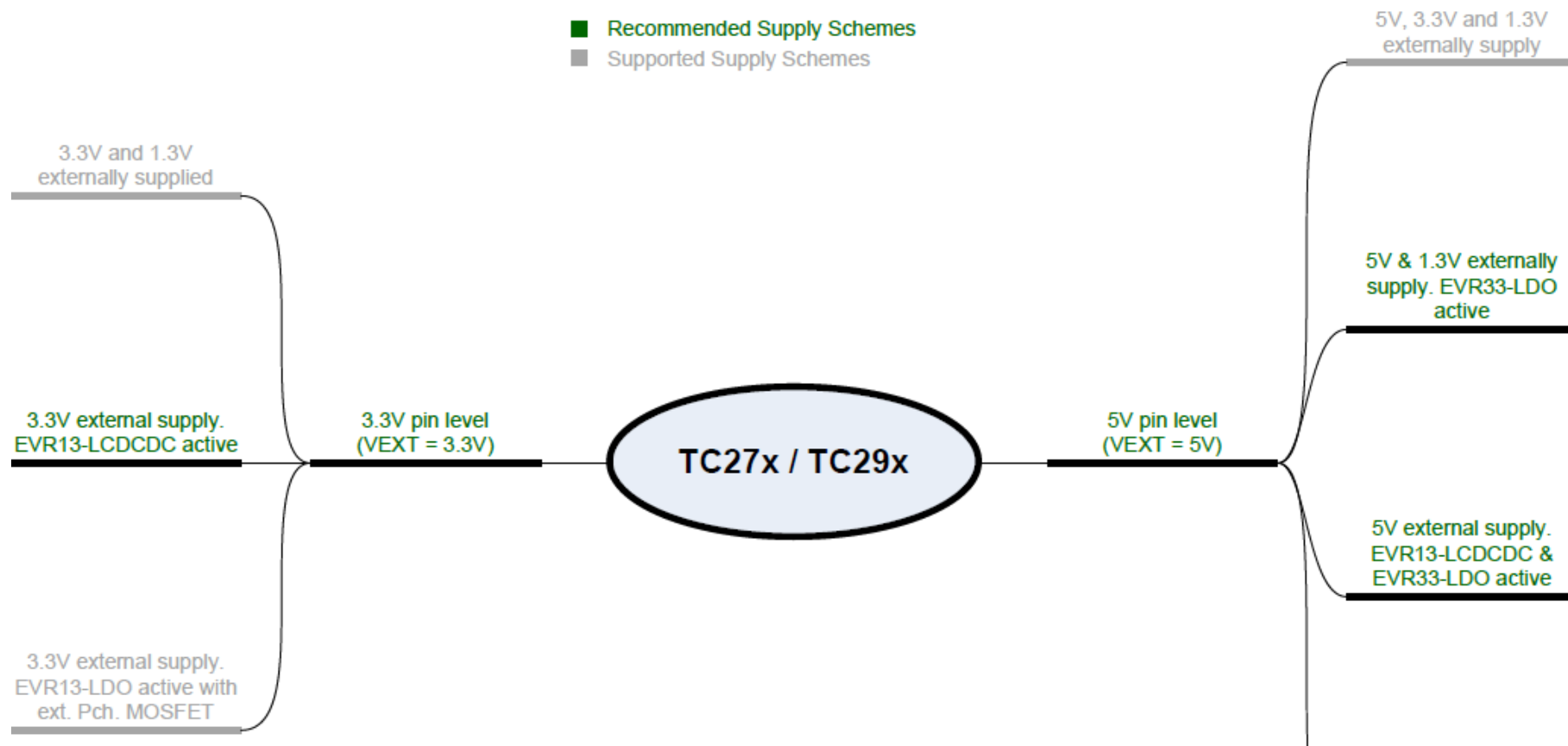


# TC275内部EVR的主要拓扑

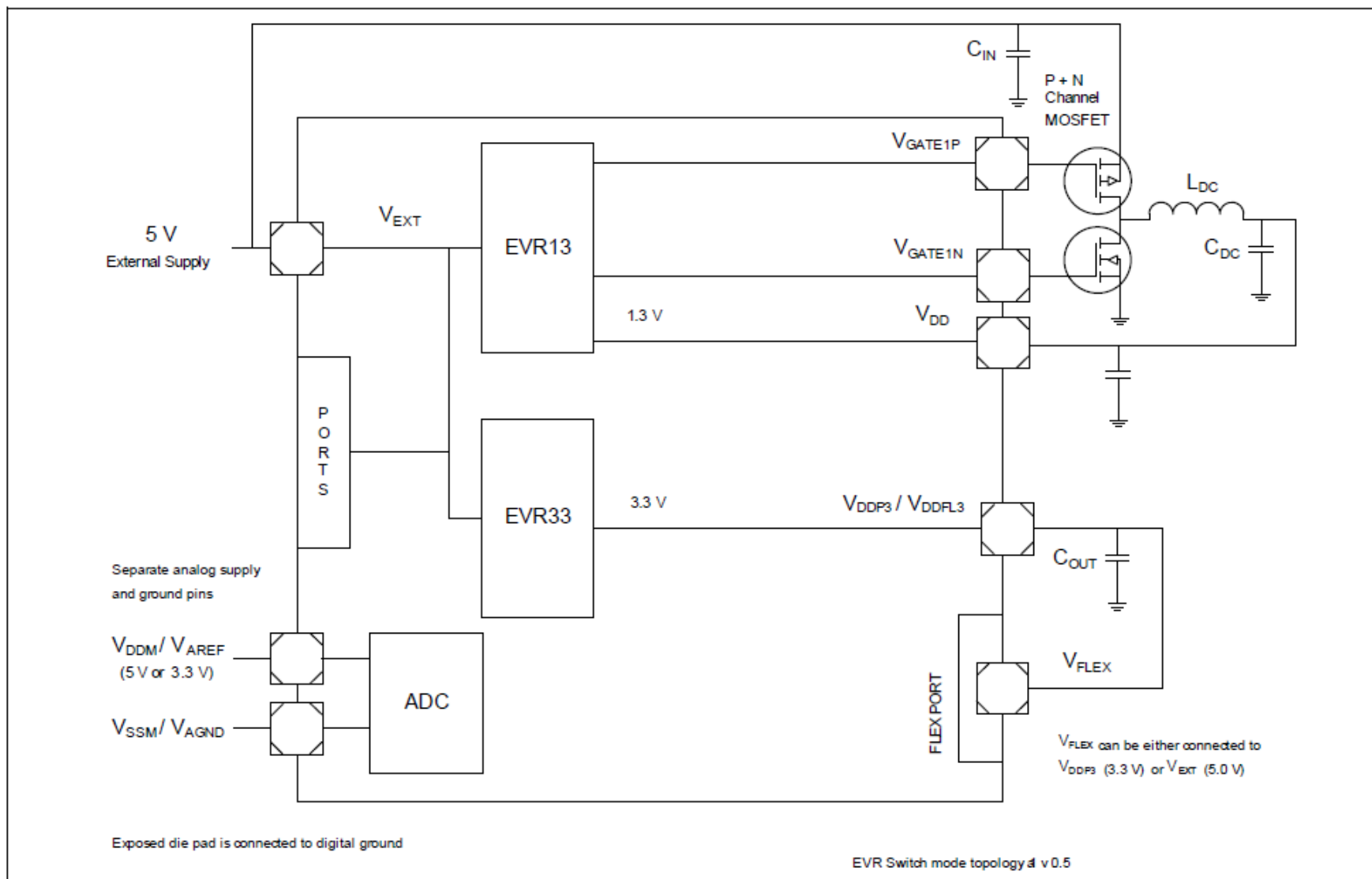
HWCFG [0] P14.6	HWCFG [1] P14.5	HWCFG [2] P14.2	HWCFG [3] P14.3	HWCFG [4] P10.5	HWCFG [5] P10.6	HWCFG [6] P14.4
						
0 - SMPS 1 - LDO (default)	0 - EVR33OFF 1 - EVR33ON (default)	0 - EVR13OFF 1 - EVR13ON (default)				

- Single source 5 V supply level is supported in following topologies.
  - EVR13 in SMPS mode with external switches and EVR33 in LDO mode with internal pass devices.
  - EVR13 in LDO mode with external pass device and EVR33 in LDO mode with internal pass devices.
- Single source 3.3 V supply level is supported in following topologies.
  - EVR13 in SMPS mode with external switches and EVR33 is inactive.
  - EVR13 in LDO mode with external pass device and EVR33 is inactive.
- Supplies are provided externally and the respective EVRs are in disabled state.
  - 5 V and 1.3 V supplied externally. EVR33 in LDO mode with internal pass devices.
  - 5 V and 3.3 V supplied externally. 1.3 V is generated using the EVR13.
  - 5 V, 3.3 V and 1.3 V are supplied externally.

# TC275内部EVR推荐的拓扑

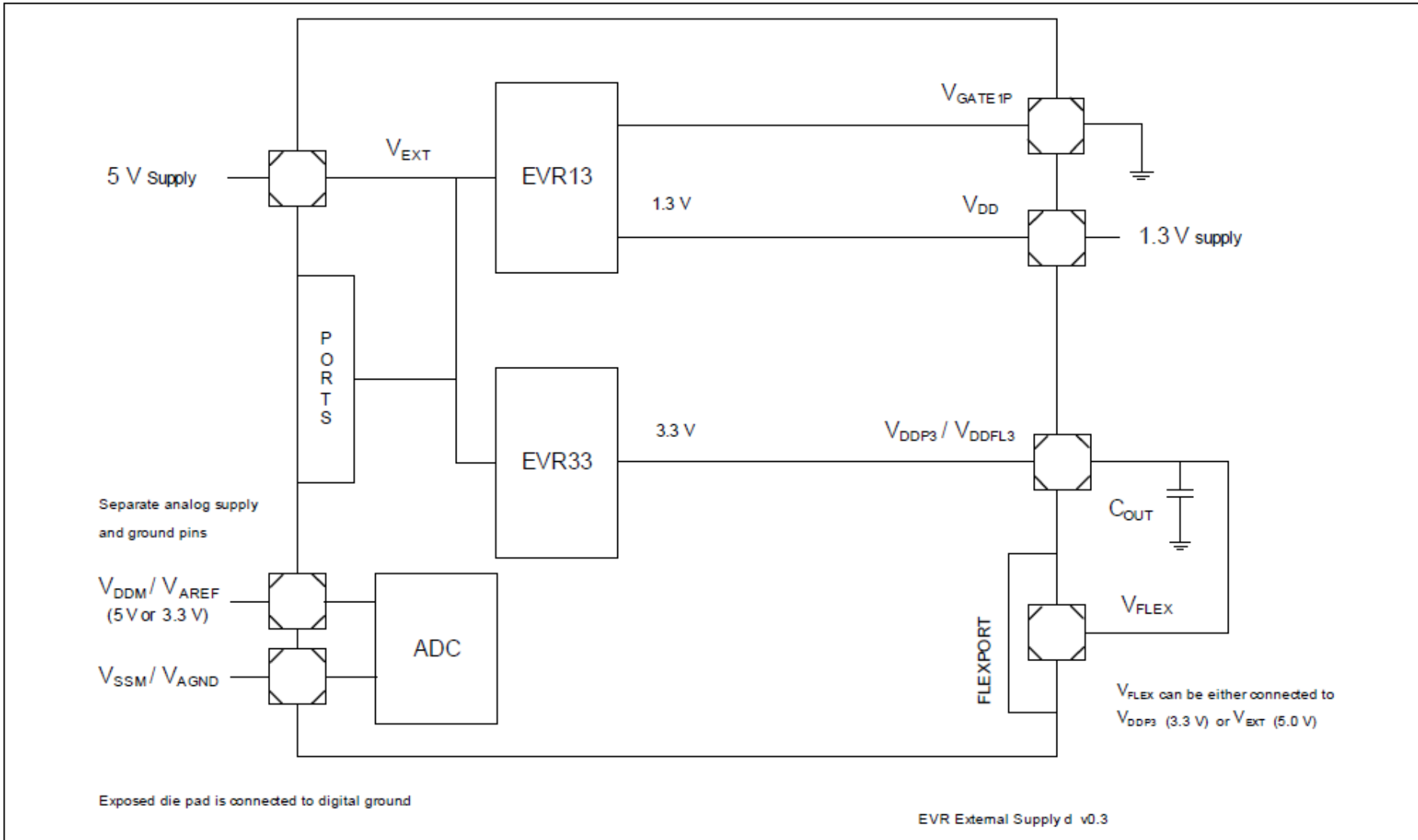


# TC275内部EVR推荐的拓扑 (a)



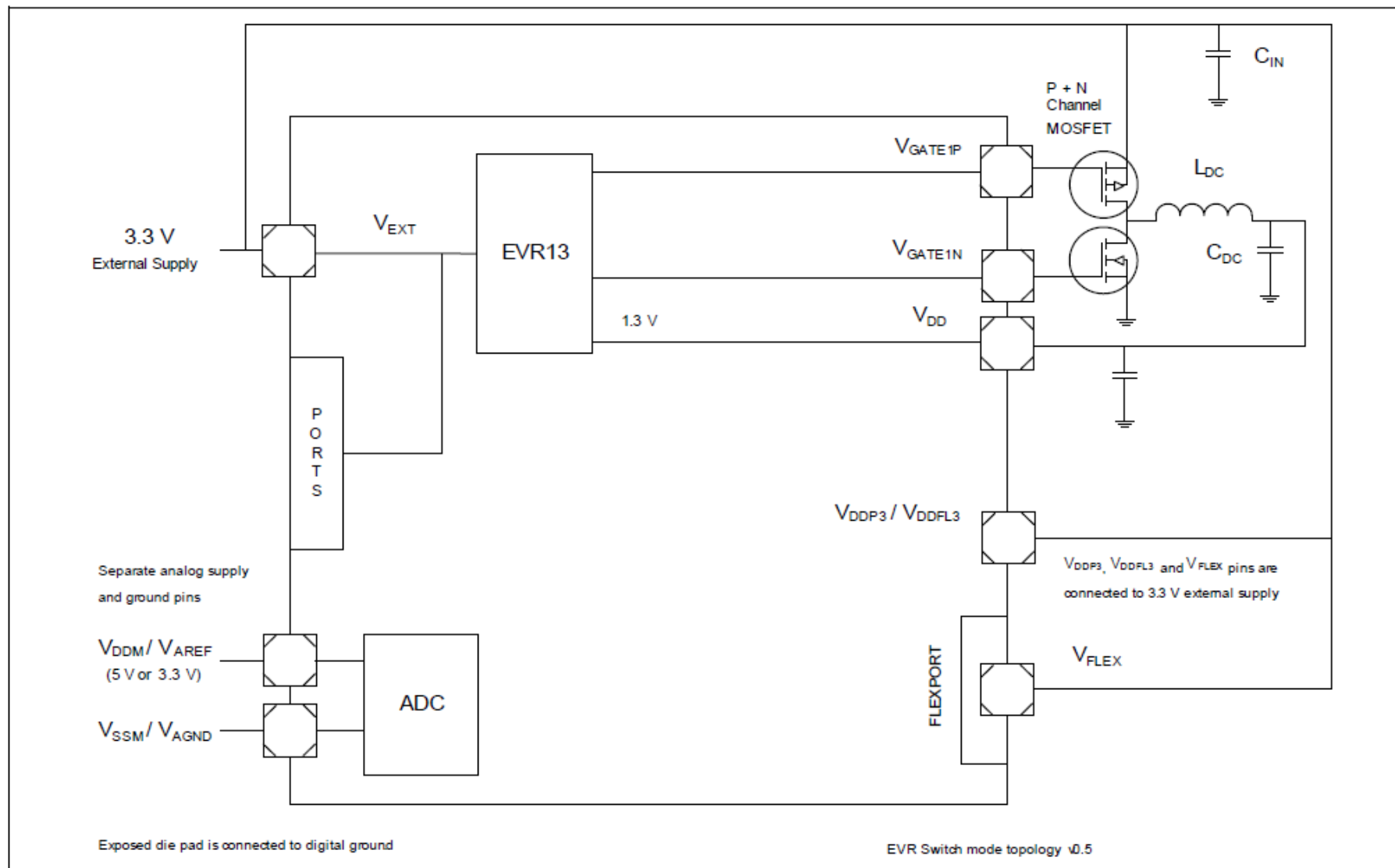
**Figure 8-26 EVR Switch mode topology (a) - 5 V single supply**

# TC275内部EVR推荐的拓扑 (d)



**Figure 8-29 External Supply mode (d) - 5 V and 1.3 V externally supplied**

# TC275内部EVR推荐的拓扑 (e)



**Figure 8-27 EVR Switch mode topology (e) - 3.3 V single supply**

# TLF35584 System Supply General Information

## ■ General

### ■ PG-VQFN-48

- As TLF35584**QV**
- With lead-tip-inspection
- Footprint: 7mm x 7mm
- Pitch: 0.5



### ■ PG-LQFP-64 (coming with delay vs VQFN)

- As TLF35584**QK**
- Footprint: 12mm x 12mm
- Pitch: 0.5

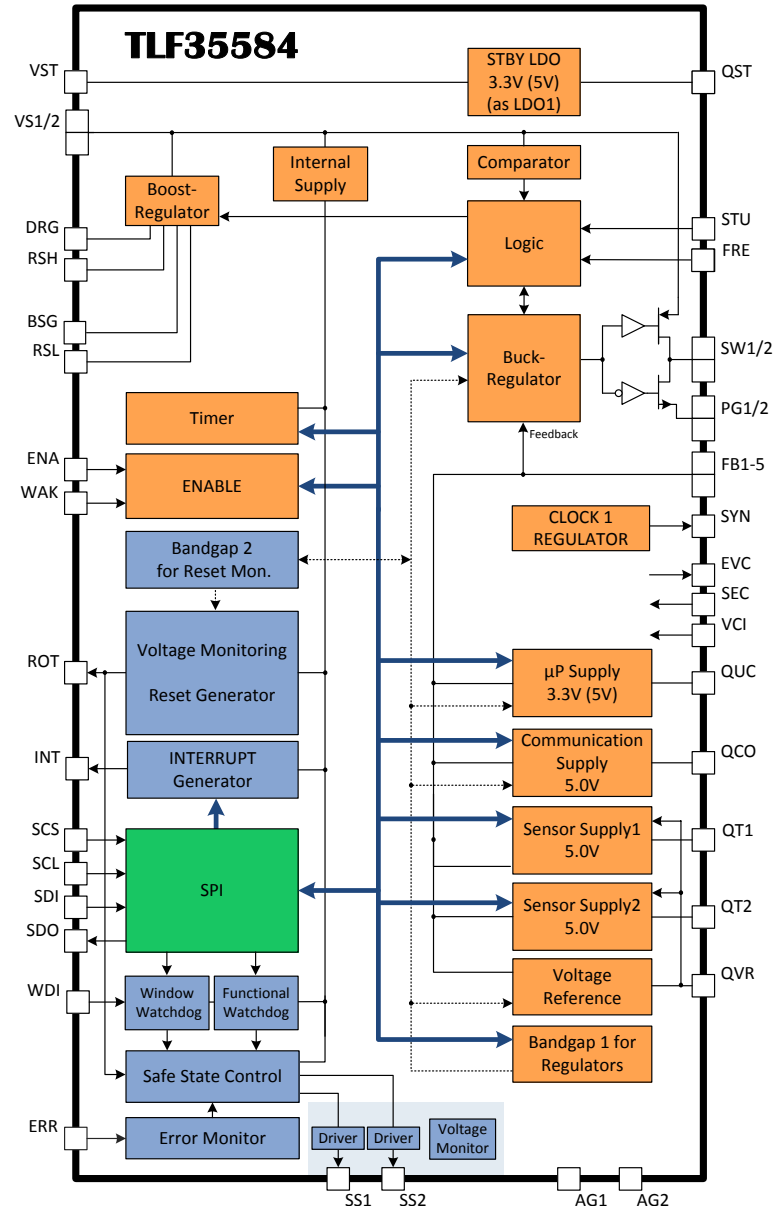


- Vin: 3V .. 40V  
(45V transient, 60V with rise time >10ms)
- Tj: -40° C .. 150° C  
(extension to be checked on request acc. customer temperature-profile for PG-LQFP-64)
- Development acc. Safety Standards  
(ISO26262)



Sales Name	Package	LDO1	Stanby-LDO	LDO2	Tracker 1 & 2	Ref.-LDO
TLF35584QV <b>VS1</b>	PG-VQFN-48	5V	5V	5V	5V	5V
TLF35584QV <b>VS2</b>	PG-VQFN-48	3.3V	3.3V	5V	5V	5V
TLF35584QK <b>VS1</b>	PG-LQFP-64	5V	5V	5V	5V	5V
TLF35584QK <b>VS2</b>	PG-LQFP-64	3.3V	3.3V	5V	5V	5V

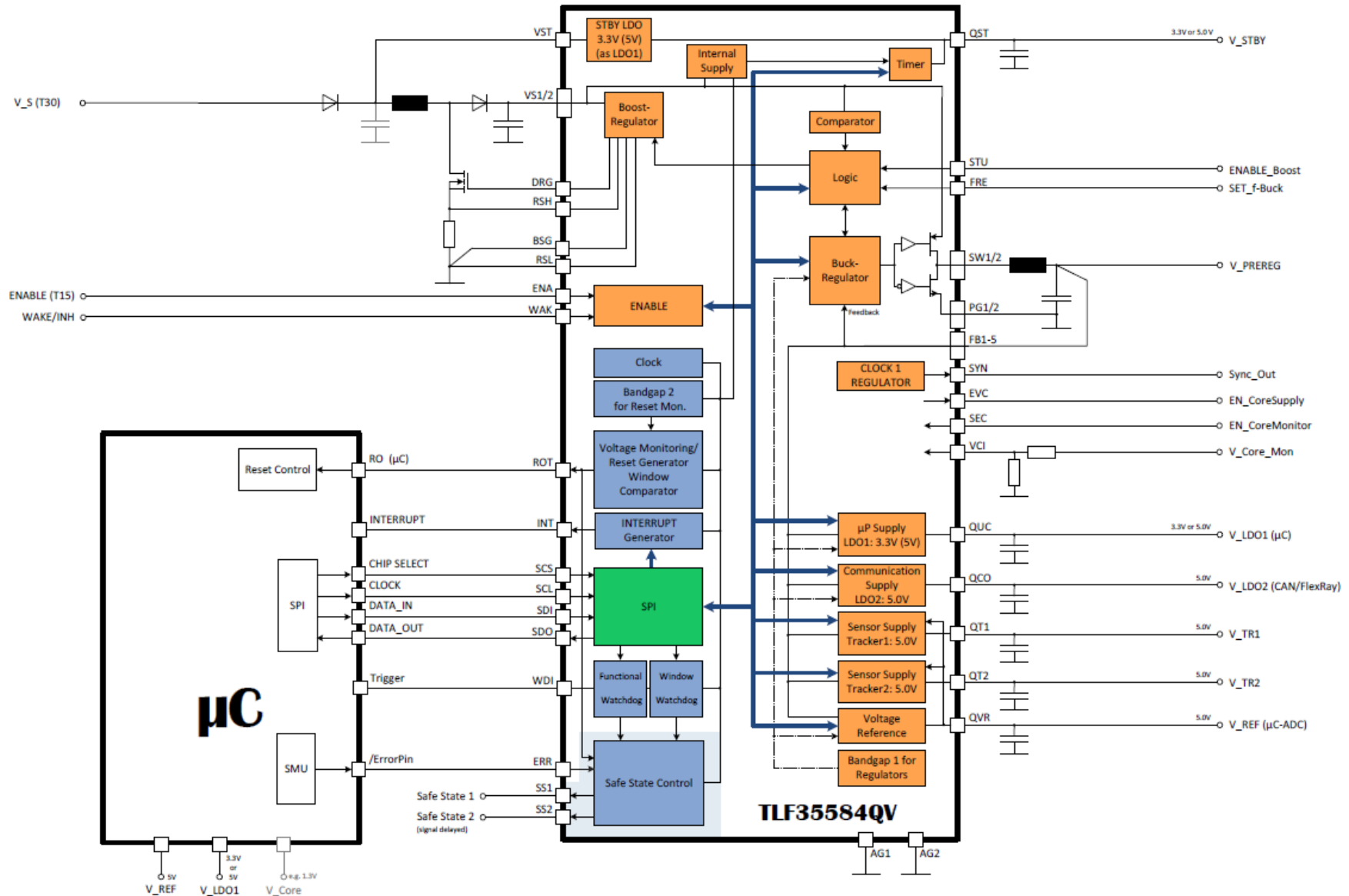
# TLF35584 System Supply Block Diagram



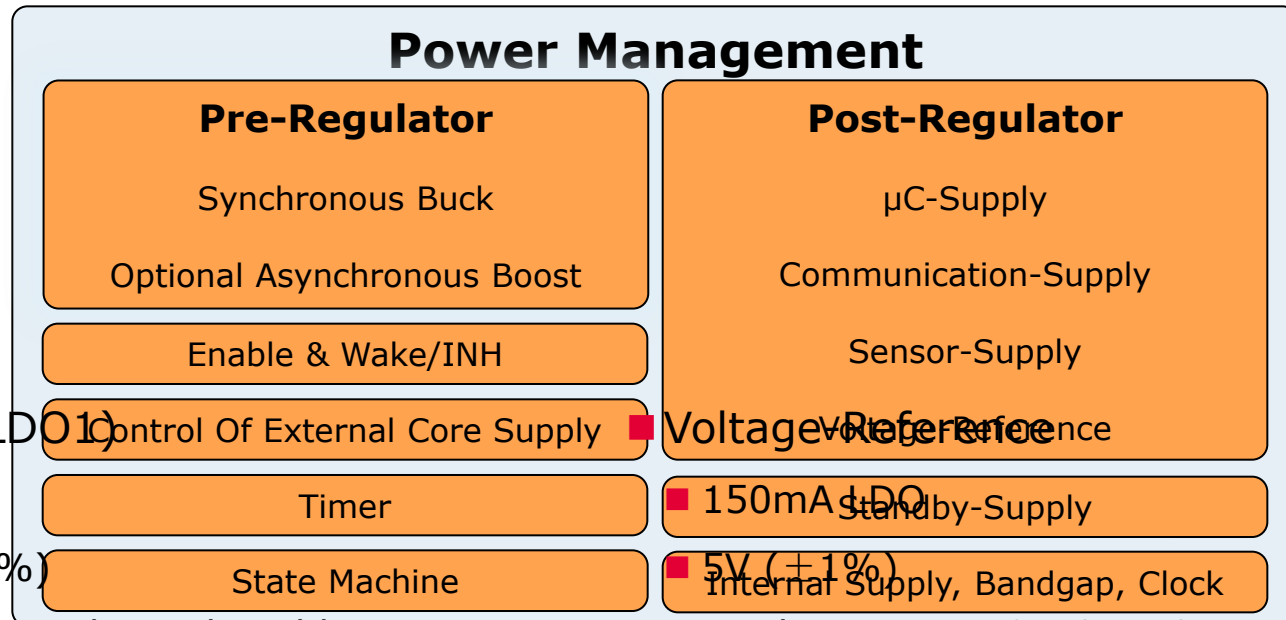


# TLF35584

## Application Diagram



# TLF35584 System Supply Post-Regulator

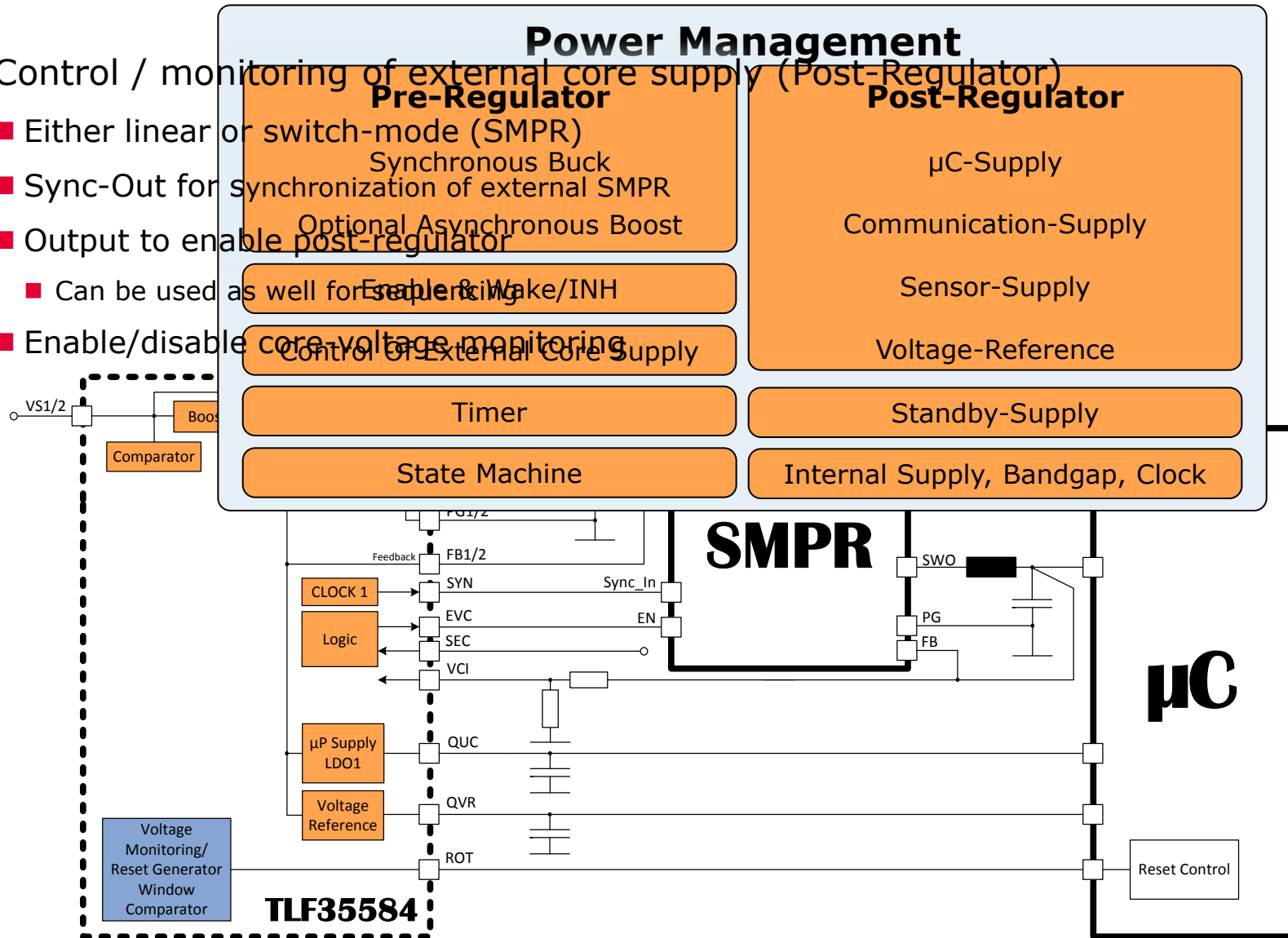


- μC-Supply (LDO1)
  - 600mA LDO
  - 3V3/5V ( $\pm 2\%$ )
  - Voltage part number selectable
- Communication-Supply (LDO2)
  - 200mA LDO
  - 5V ( $\pm 2\%$ )
- 10mA LDO
- 3V3/5V (2%); same voltage as LDO1
- Voltage Reference
  - 150mA LDO Standby-Supply
  - 5V ( $\pm 1\%$ ) Internal Supply, Bandgap, Clock
  - Tracking source & μC-ADC-supply
- Sensor-Supply (Tracker)
  - 2x 150mA
  - 5V ( $\pm 10\text{mV}$  tracking accuracy)

# TLF35584 System Supply Control of external core supply

- Control / monitoring of external core supply (Post-Regulator)

- Either linear or switch-mode (SMPR)
  - Synchronous Buck
  - Optional Asynchronous Boost
- Sync-Out for synchronization of external SMPR
- Output to enable post-regulator
  - Can be used as well for Enable/Wake/INH
- Enable/disable core voltage monitoring

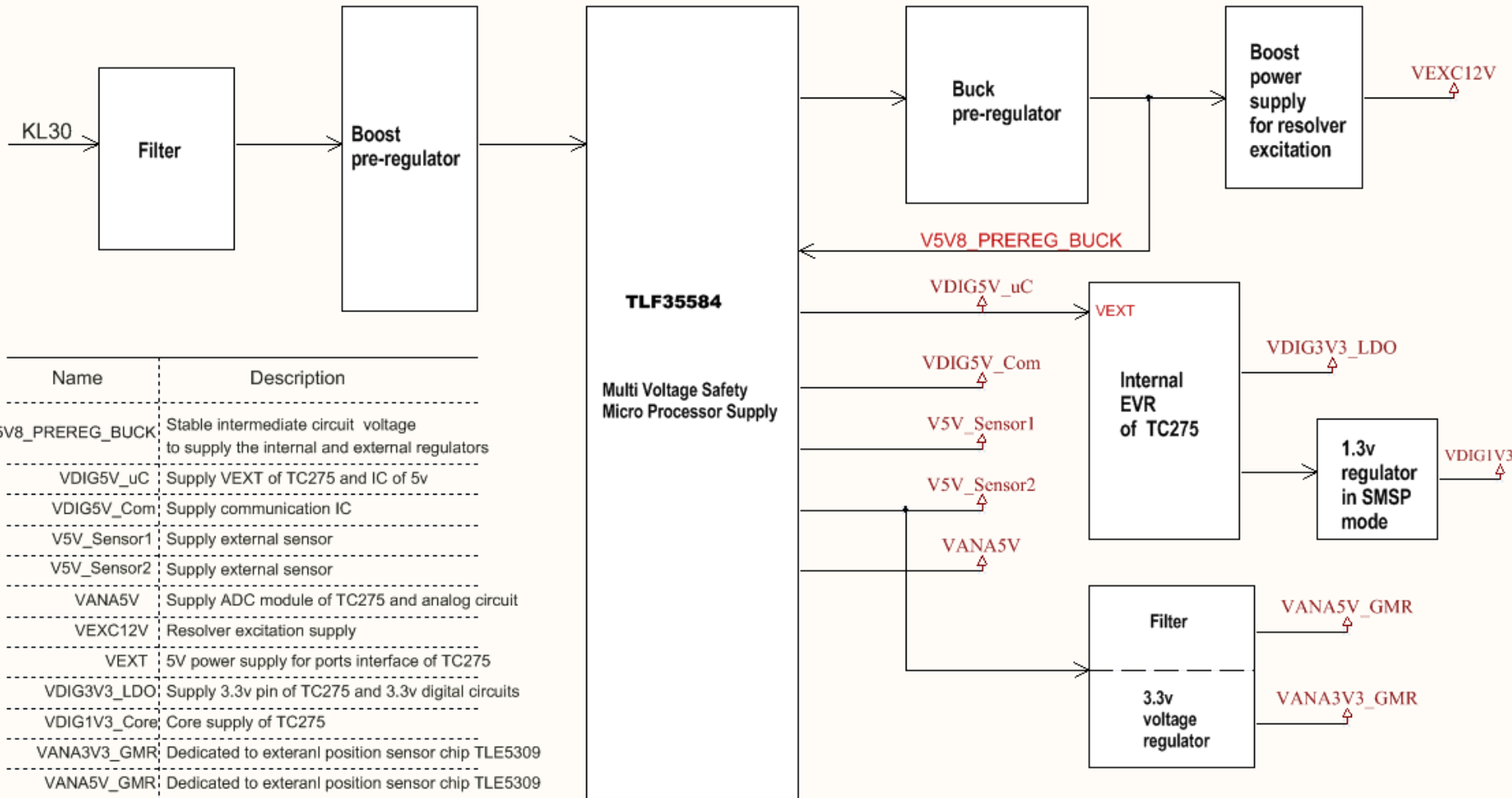


# OIKOS-Gen2 开发板需要的电源及方案设计的考虑

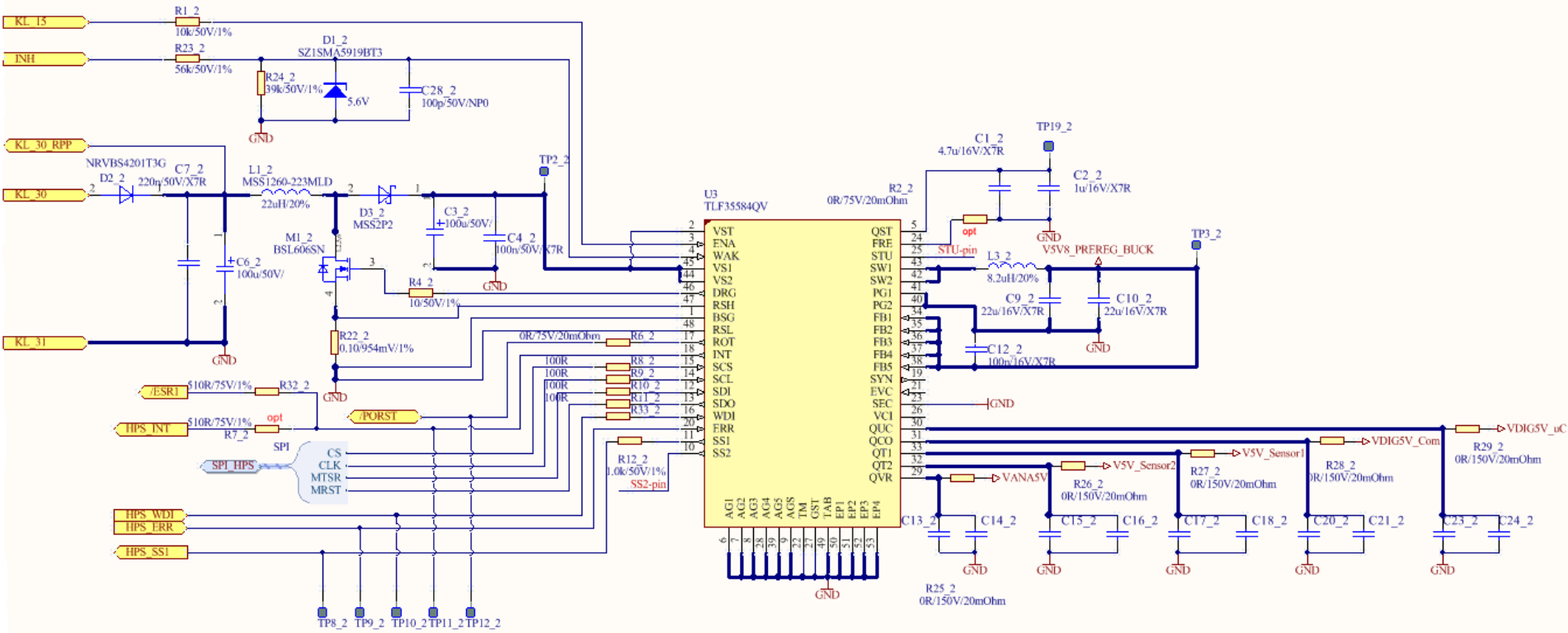
Name	Description
V5V8_PREREG_BUCK	Stable intermediate circuit voltage to supply the internal and external regulators
VDIG5V_uC	Supply VEXT of TC275 and IC of 5v
VDIG5V_Com	Supply communication IC
V5V_Sensor1	Supply external sensor
V5V_Sensor2	Supply external sensor
VANA5V	Supply ADC module of TC275 and analog circuit
VEXC12V	Resolver excitation supply
VEXT	5V power supply for ports interface of TC275
VDIG3V3_LDO	Supply 3.3v pin of TC275 and 3.3v digital circuits
VDIG1V3_Core	Core supply of TC275
VANA3V3_GMR	Dedicated to external position sensor chip TLE5309
VANA5V_GMR	Dedicated to external position sensor chip TLE5309

- 功能安全的需求
- 单片机I/O口逻辑电平VEXT的确定
  - 外围芯片接口电平
  - 外围sensor接口电平
- 单片机模拟单元电平VDDM的选择
- 可靠性
- TC275的工作温升
- 电源部分的总成本
- etc

# OIKOS-Gen2 开发板电源部分原理框图



# OIKOS-Gen2 开发板电源部分原理图

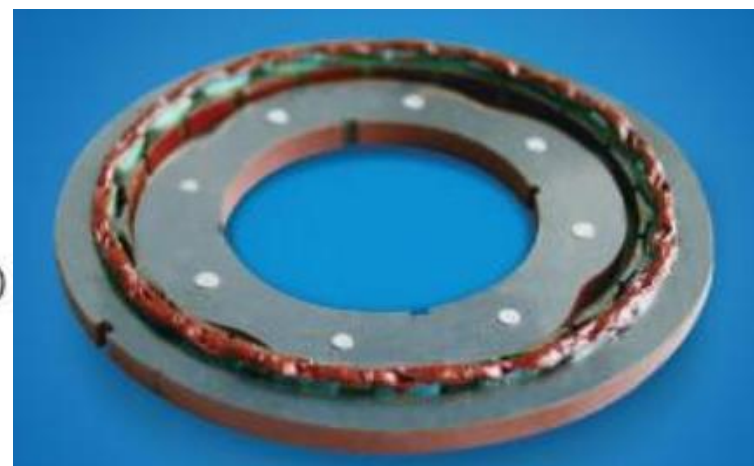
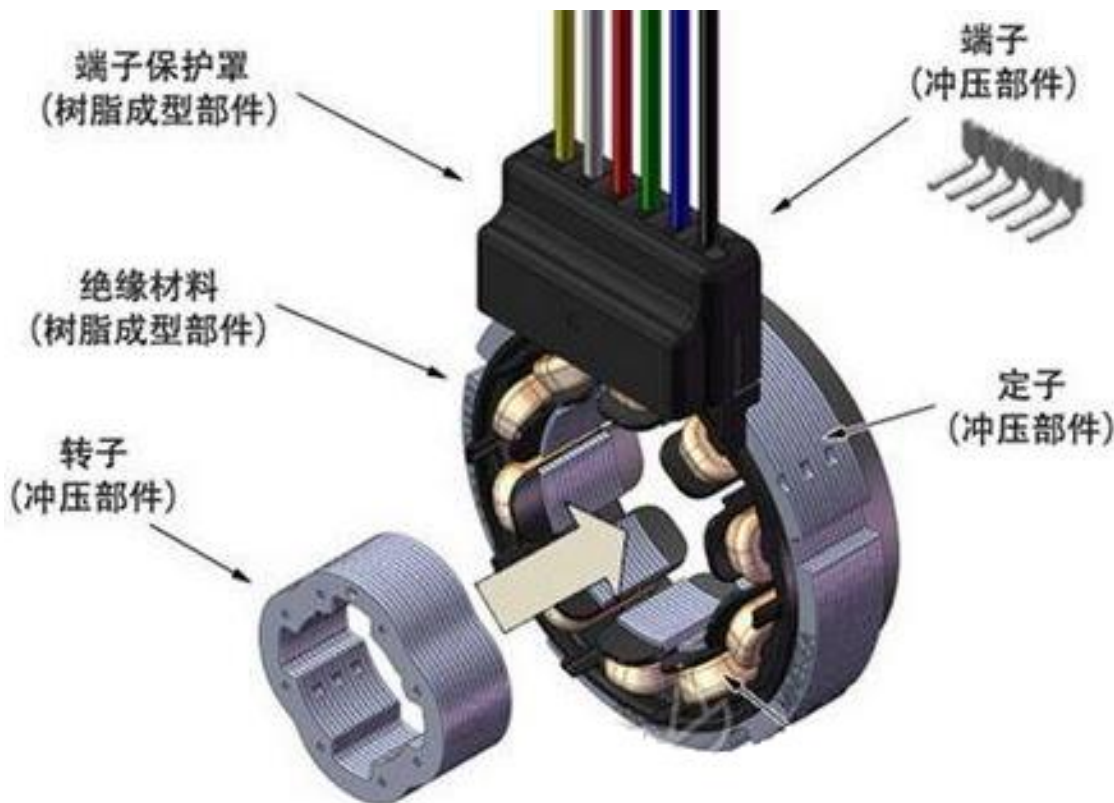
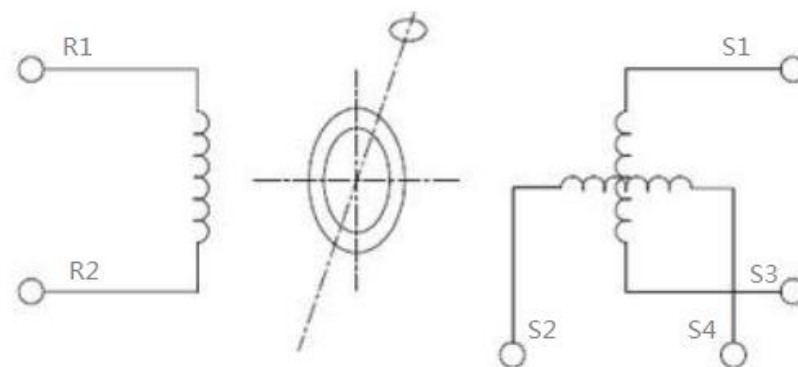


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# 旋转变压器

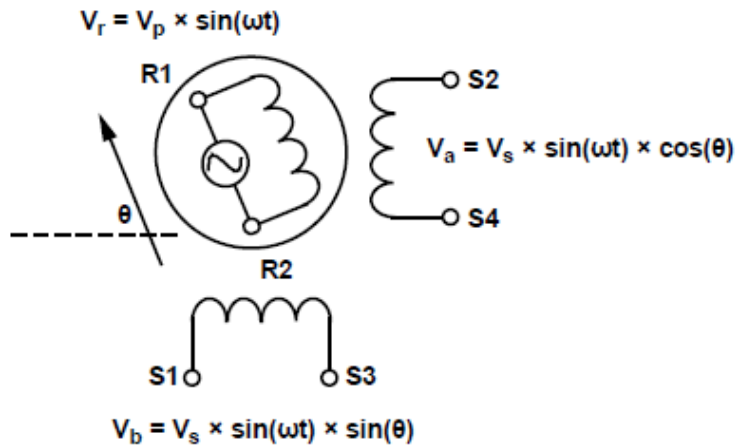
- 主要用于转子位置检测
- 差分模拟量传输
- 可靠性高



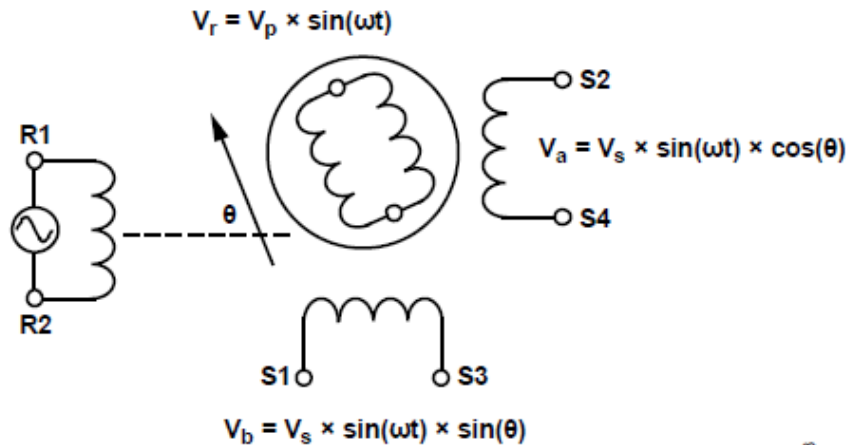


# 旋变的输入输出信号公式

## ■ The structure of resolver



(A) CLASSICAL RESOLVER



(B) VARIABLE RELUCTANCE RESOLVER

07467-023

■ The excitation signal: R1-R2 =  $V_{in} = V_s * \sin(\omega t)$

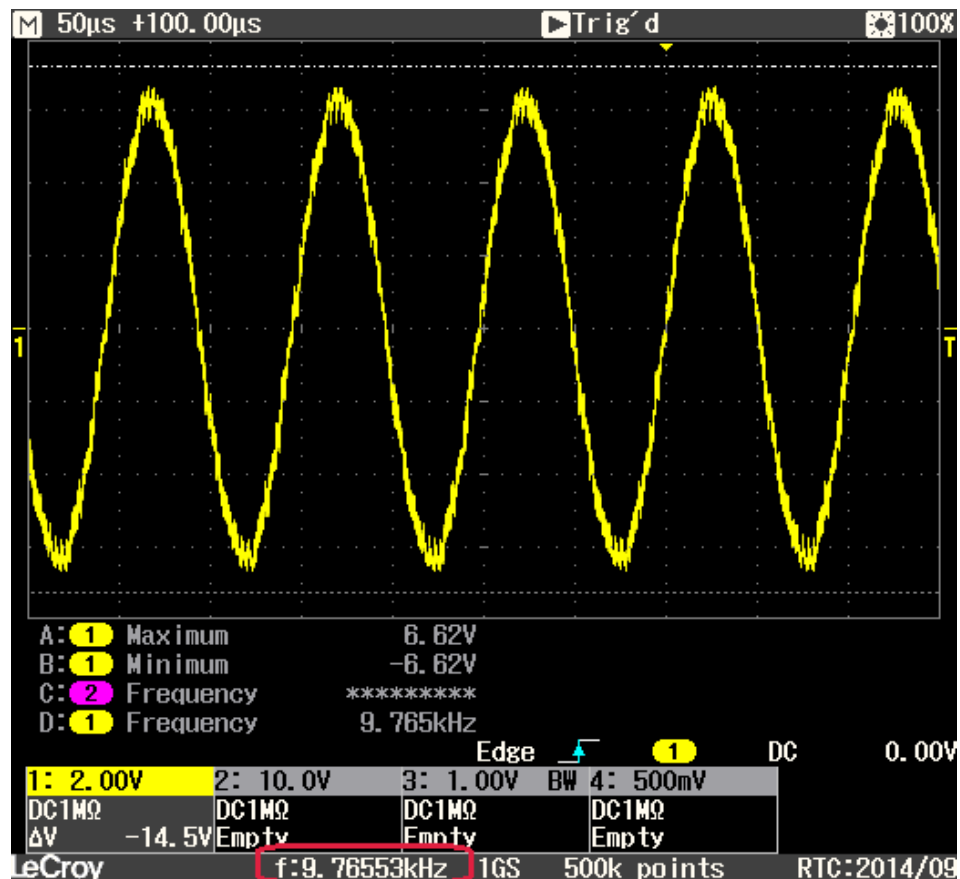
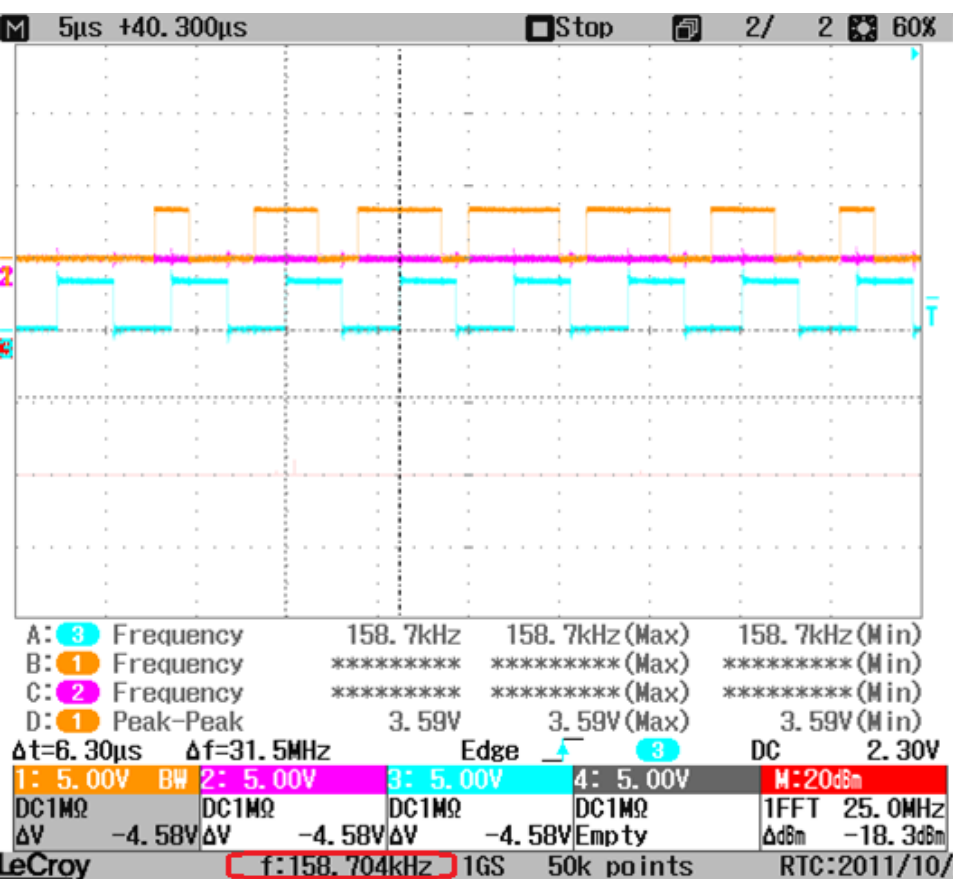
■ The output signals:

$$S2-S4 = V_{sin} = V_s * \sin(\omega t) * \sin\theta$$

$$S1-S3 = V_{cos} = V_s * \sin(\omega t) * \cos\theta$$

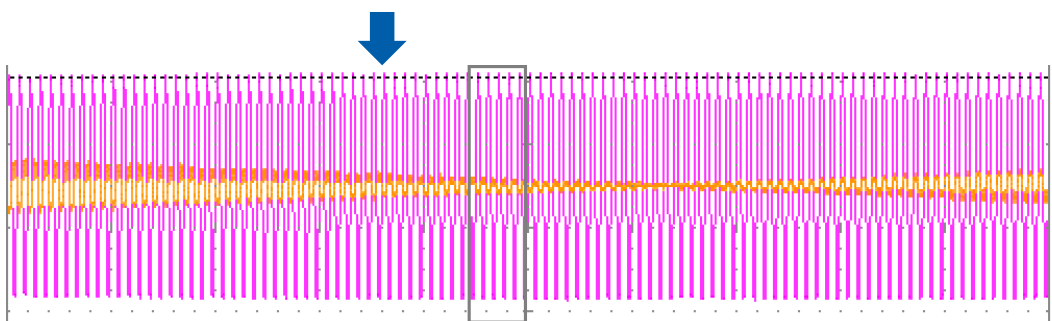
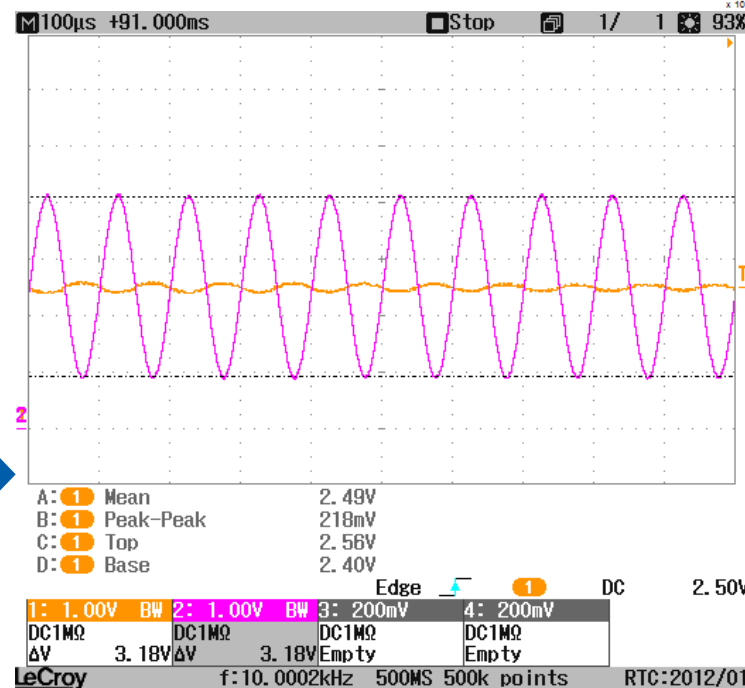
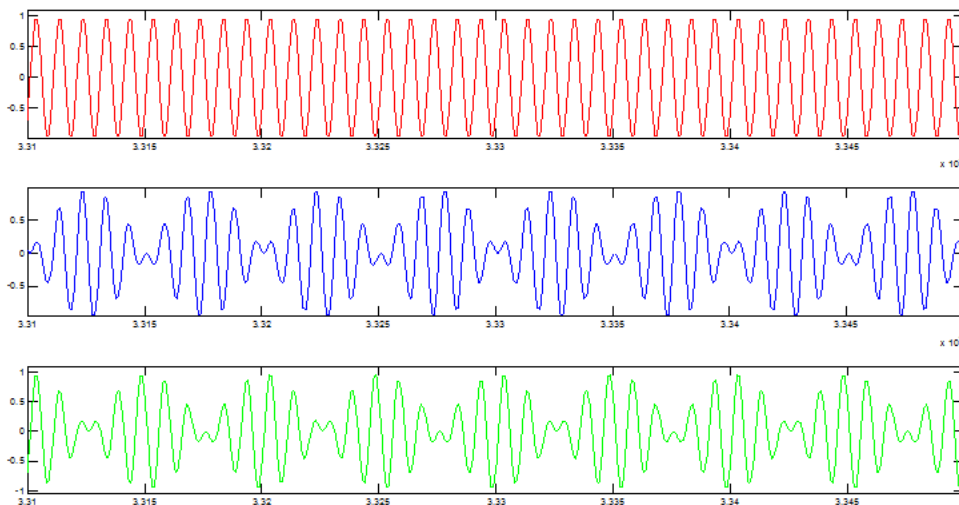
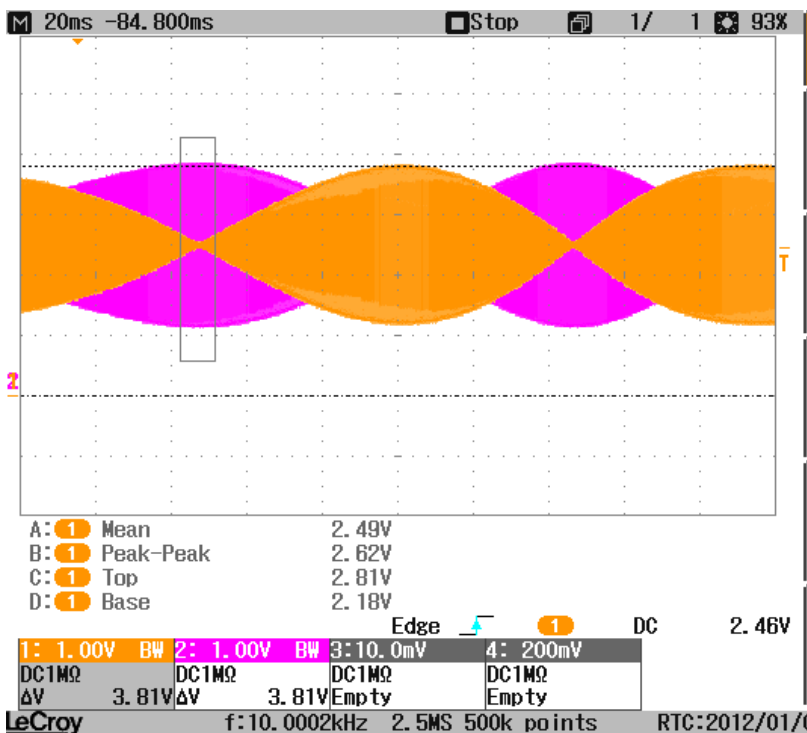
# 旋变的输入激励信号

- 激励信号需要10-20KHz的频率
- 激励信号可以通过专门的解码芯片产生，也可以用MCU产生
- 下图是MCU用160KHz的SPWM造出10KHz的正弦激励信号



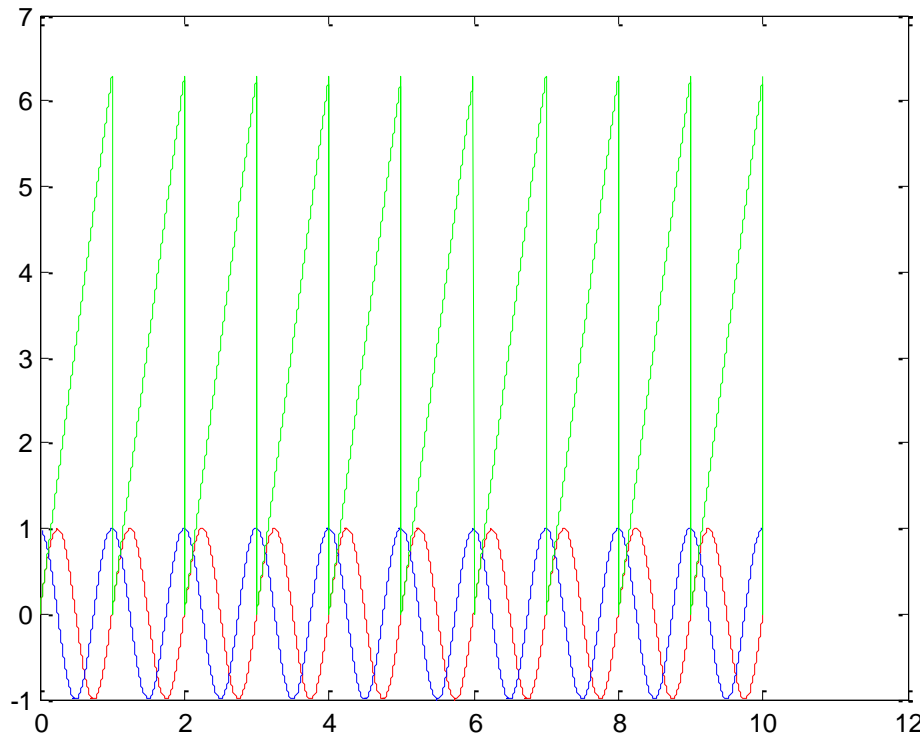
# 旋变输出的两路信号

■ 两路差分输出信号: S1\_3, S2\_4



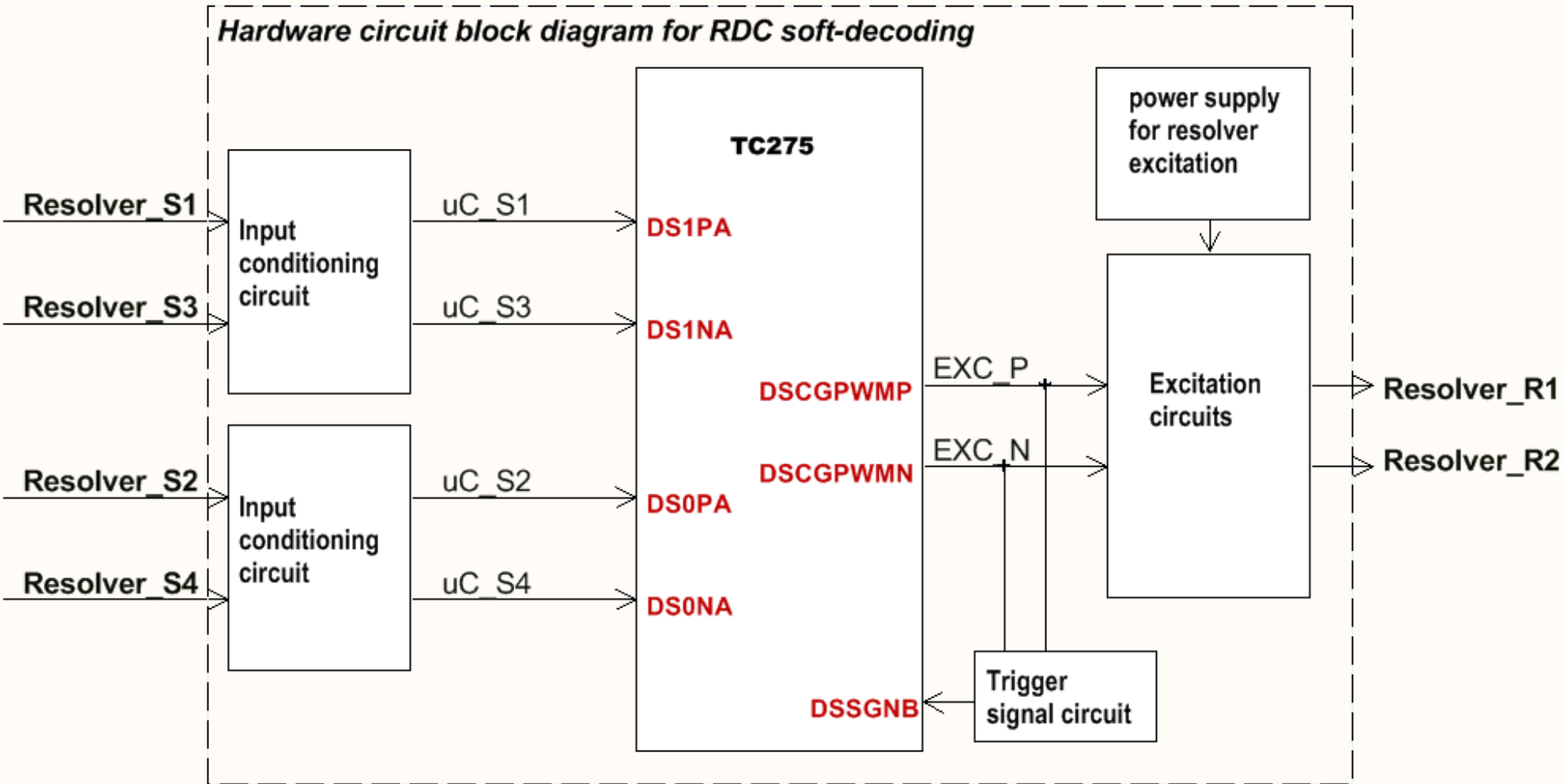
# 角度的计算

- 从旋变输出的两路差分信号经过滤波、增益调节等调理电路处理后给到计算单元
- 计算单元可以是专门的解码芯片，也可以是MCU的ADC单元
- 下图是TC275的DSADC以160KHz的频率AD采样，并经过软件处理后根据公式  $\Theta = \arctan (V_{\sin} / V_{\cos})$  得出的正余弦及角度（仿真结果@没有噪声）



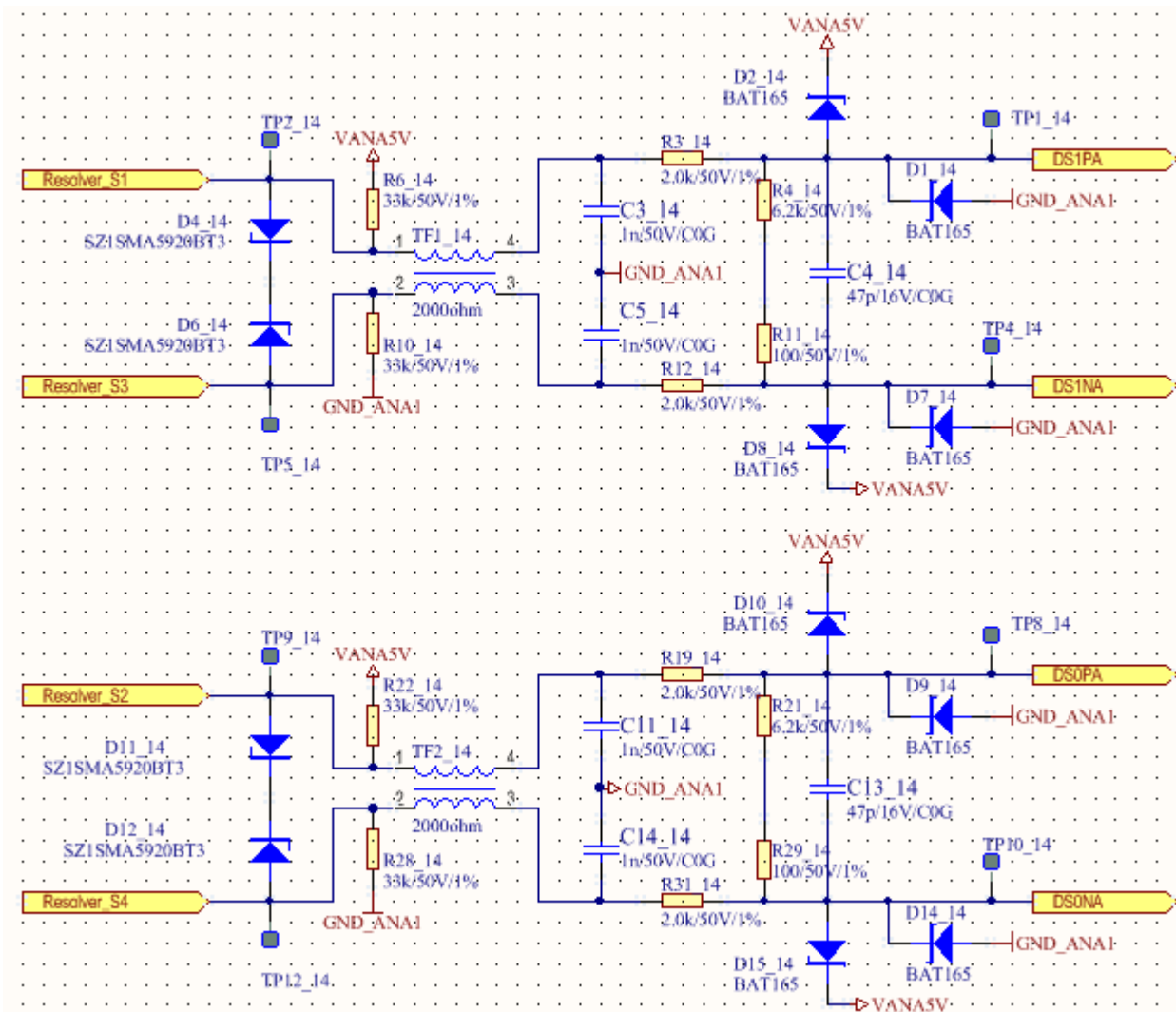
# RDC (Resolver to Digital Converter)

## 软解码所需的硬件电路框图

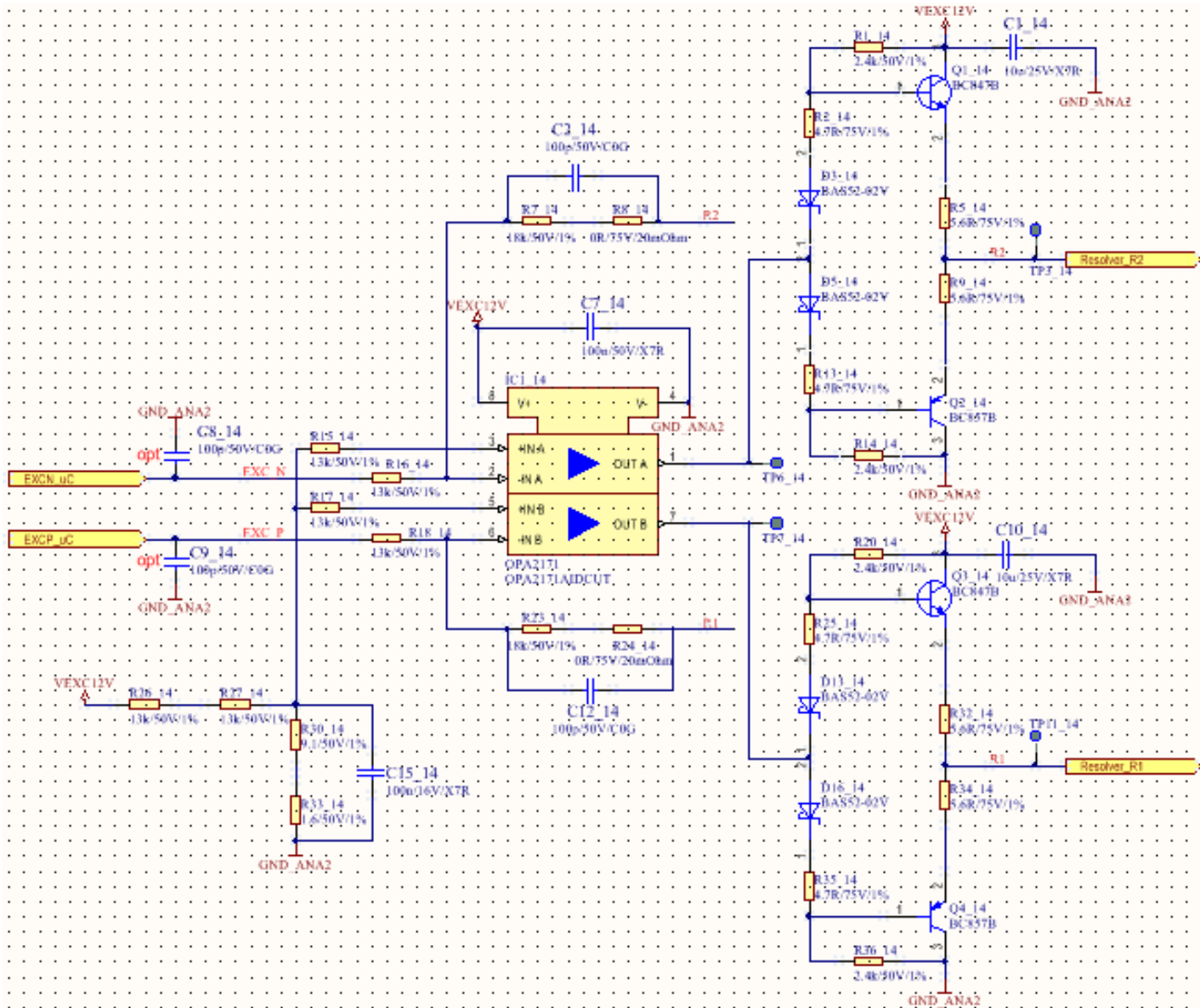


# 输入调理电路

- 滤波
- 增益调节
- 开路监测
- 过欠压钳位

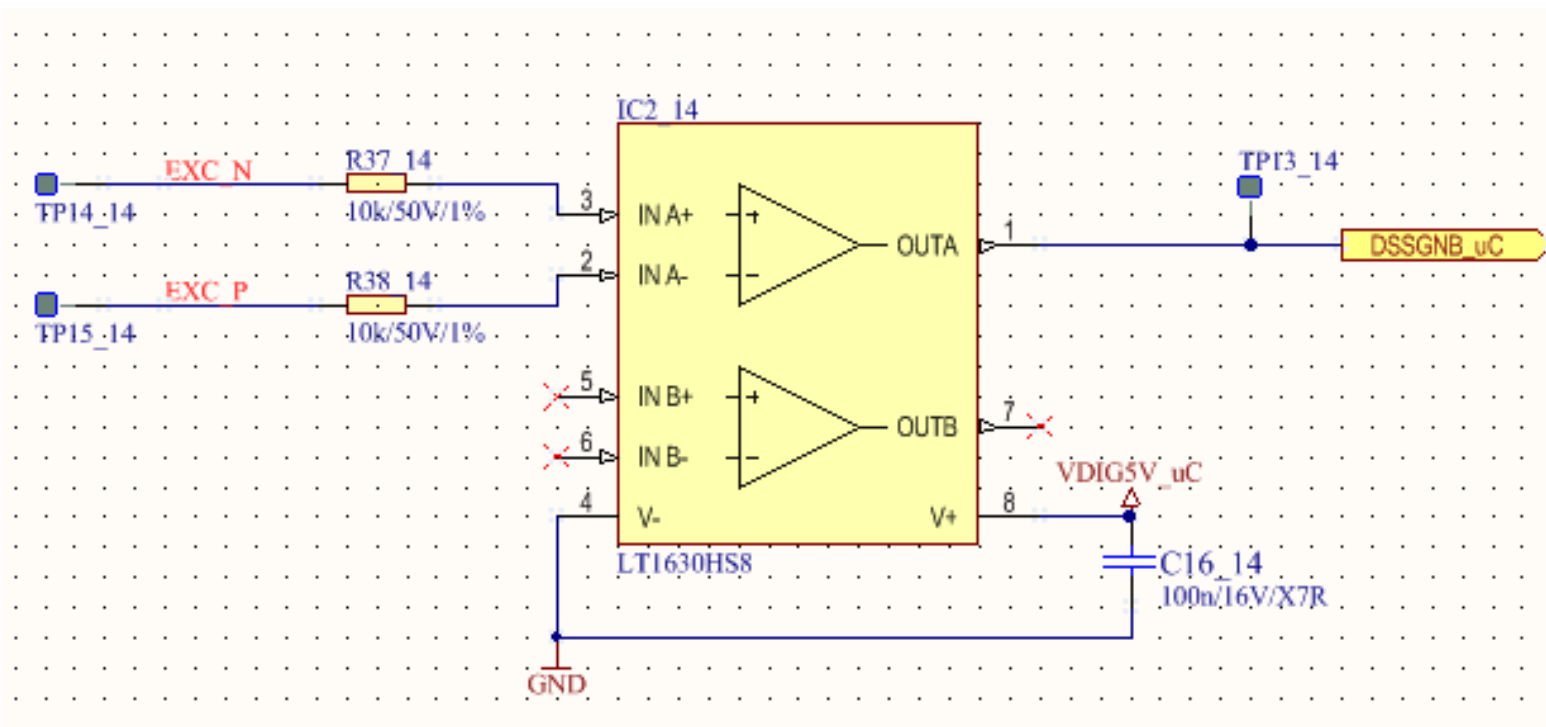


# 激励输出电路



# 触发信号产生电路

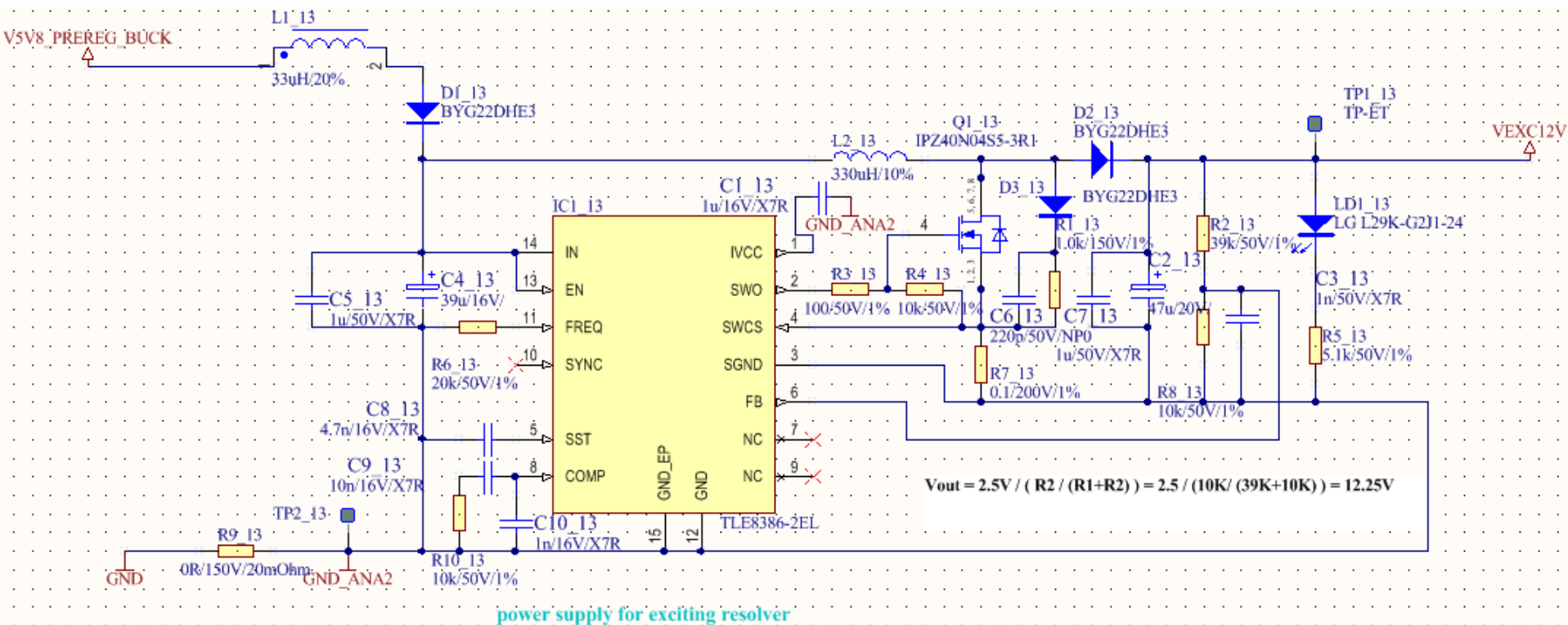
## ■ 产生内部所需的触发信号





# 激励输出电源电路

## ■ 产生激励电路所需的12V





# ENERGY EFFICIENCY MOBILITY SECURITY

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