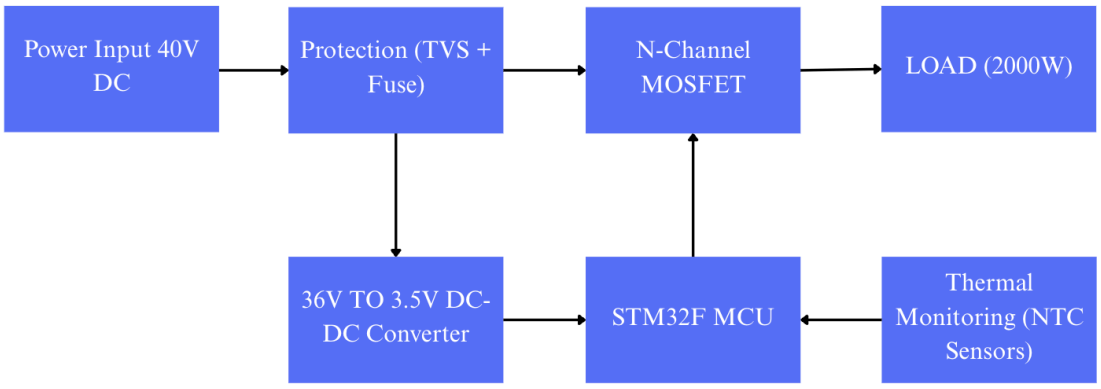
DC Load Control Circuit System

Overview

This project involves designing a DC power management and load control system that converts a 40V DC input into a regulated 36V output, controls a high-power load (~2000W), and provides monitoring and switching capabilities using an STM32 microcontroller. The circuit incorporates power regulation, protection features, **temperature monitoring(1)**, and logic-level control of **MOSFETs**.

System Block Diagram



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Component Selection Justification Table

Component	Part Number / Value	Function	Reason for Selection
XT60 Connector (U5)	XT60	High-current DC input terminal	Robust, widely used for high-power connections; supports 60A+
PTC Fuse (U7)	MF-RX050/72	Overcurrent protection	Resettable, simple protection without needing replacement
TVS Diode (D2)	P6KE43A	Surge suppression	Clamps voltage spikes >43V, protects DC-DC converter
Input Capacitor (C5)	100µF / 63V	Input voltage filtering	Handles ripple and voltage fluctuations from the source
DC-DC Converter (U6)	XL4016E1	Steps 40V down to 36V	High-efficiency buck converter; handles high current
Output Capacitor (C6)	100µF / 50V	Output ripple smoothing	Provides clean, stable power to load
MOSFET (Q2)	IRLZ44NPBF	Load switching	Logic-level gate (3.3V capable); high current (up to 100A peak)
Gate Resistor (R5)	10Ω	Limits gate inrush current	Prevents damage from fast switching and gate ringing
Pulldown Resistor (R6)	10kΩ	Keeps gate LOW when MCU is idle	Prevents false triggering; ensures gate is grounded
Flyback Diode (U8)	1N5822	Protects from reverse EMF	Fast recovery; handles high surge current; ideal for inductive loads
Microcontroller (U13)	STM32F103C8T6	System control and sensor interface	32-bit performance, multiple ADCs, GPIOs; widely supported

NTC Thermistors (U14–U17)	10kΩ B=3950	Temperature sensing	Accurate, simple voltage-divider temperature monitoring
Pull-up Resistors (RNTC)	10kΩ	Voltage divider bias for NTCs	Standard value for ADC-compatible voltage ranges
Decoupling Capacitors (C14–C16)	100nF	Power supply stability near MCU	Filters noise; improves reliability of logic signals
LDO Regulator (U_REG)	AMS1117-3.3	3.3V power supply for MCU	Simple, cost-effective linear regulator
Load Connector (P7)	XT60 / KF301	Load output terminal	Handles high current; screw terminals or XT60 are reliable
Signal Header (P8)	2-pin Header	Gate control signal from MCU	Simple GPIO interface; enables external MCU or manual control
PCB Material	FR4, 1.6mm, 2-layer	Circuit support and trace layout	Standard, cost-effective, suitable for moderate thermal load