Internal distribution code:

(A) [-] Publication in OJ
(B) [-] To Chairmen and Members
(C) [-] To Chairmen
(D) [X] No distribution

Datasheet for the decision of 21 February 2024

Case Number: T 1602/20 - 3.5.02

Application Number: 11808415.1

Publication Number: 2659577

IPC: H02M3/157, H02M3/158

Language of the proceedings: EN

Title of invention:
Relative efficiency measurement in a converter with pulse width modulation

Applicant:
Microchip Technology Incorporated

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - main request (yes)

Europäisches Patentamt
European Patent Office
Office européen des brevets

Beschwerdekammern

Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 1602/20 - 3.5.02

D E C I S I O N
of Technical Board of Appeal 3.5.02
of 21 February 2024

Appellant: (Applicant)	Microchip Technology Incorporated 2355 West Chandler Boulevard Chandler, AZ 85224-6199 (US)
Representative:	sgb europe Lechnerstraße 25a 82067 Ebenhausen (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 24 February 2020 refusing European patent application No. 11808415.1 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	R. Lord
Members:	H. Bronold
	R. Cramer

Summary of Facts and Submissions

I. The patent applicant (appellant) appealed against the decision of the examining division refusing European patent application No. 11 808 415.1 for lack of inventive step.

The examining division found that the subject-matter of independent apparatus claim 1 according to all requests pending before it lacked an inventive step starting from document D3 (US 6,351,396 B1). Further, the examining division found that the subject-matter of independent method claim 11 according to the main request, the first auxiliary request and the second auxiliary request lacked an inventive step over a combination of document D3 with document D1 (US 7,825,642 B1).

II. The appellant requested in their statement setting out the grounds of appeal that the decision under appeal be set aside and that a patent be granted according to their main request or on the basis of the claims of their auxiliary request, both filed together with the statement setting out the grounds of appeal. The main request is, apart from a minor clarification, identical to the main request underlying the contested decision. The auxiliary request was filed for the first time during the appeal proceedings.

III. In a communication under Rule 100(2) EPC the board informed the appellant that it was inclined to set the contested decision aside. Further, the board tended to the opinion that the main request was not clear in the sense of Article 84 EPC and that the auxiliary request

contravened Article 123(2) EPC. The board suggested that an amended request on the basis of the auxiliary request be filed.

IV. With letter dated 3 August 2023 the appellant filed a corresponding request as new main request replacing the former requests.

V. Claim 1 according to the new main request reads as follows:

"A switch-mode power supply (SMPS), comprising:
at least one power switch (316; 318) coupled to a voltage source;
a power inductor (312) coupled to the at least one power switch (316; 318);
a filter capacitor (310) coupled to a load side of the power inductor (316; 318) that provides a regulated voltage output (V_{OUT}) of the SMPS;
at least one driver (464) coupled to the at least one power switch (316; 318);
a pulse width modulation (PWM) generator (326; 458) having at least one output coupled to and controlling the at least one driver (464), the at least one output of the PWM generator (326; 458) providing at least one PWM signal comprising a plurality of pulses;
a digital processor (462) having a memory, the digital processor (462) is coupled to and provides operating parameters to the PWM generator (326; 458) during operation thereof;
characterized by
a voltage comparison circuit (322) for comparing the regulated output voltage (V_{OUT}) to a reference voltage (V_{REF}), wherein the voltage comparison circuit (322) has an error signal output representative of a

difference between the regulated output voltage (V_{OUT}) and the reference voltage (V_{REF});
a comparator (324) having a first input coupled to the error signal output from the voltage comparison circuit (322), a second input coupled to a ramp signal (I_{SENSE}; V_{RAMP}), and an output coupled to an input of the PWM generator (326; 458);
a PWM averaging filter (328; 468), wherein the PWM averaging filter (328; 468) receives the PWM signal and produces an analog signal representative of a relative efficiency thereof; and
an analog-to-digital converter (ADC) (470) having an analog input coupled to the PWM averaging filter (328; 468) for receiving the analog signal representative of the relative efficiency of the PWM signal, and a digital output coupled to the digital processor (462) having the memory;
wherein the digital processor (462) is designated for storing in the memory digital efficiency values from the digital output of the analog-to-digital converter (ADC) (470) and wherein the digital processor (462) optimizes operation of the SMPS by adjusting operating parameters of the PWM generator (326; 458) by using the stored digital efficiency values to provide the at least one PWM signal that produces a highest relative efficiency of the SMPS."

Claims 2 to 10 are dependent on claim 1.

VI. Independent method claim 11 relates to a corresponding method for optimising efficiency of a switch-mode power supply according to one of the preceding (apparatus) claims.

Claims 12 to 15 are dependent on claim 11.

VII. The appellant's arguments which are of particular relevance for the decision are detailed below together with the reasons for the decision.

Reasons for the Decision

1. Admissibility of the appeal

The appeal was filed in due time and form and sufficiently substantiated. Therefore, the appeal is admissible.

2. Inventive step - Article 56 EPC

2.1 In the contested decision the examining division reached the conclusion that the subject-matter of claim 1 according to the then pending main request lacked an inventive step in the sense of Article 56 EPC starting from the disclosure of document D3.

The invention relates to a switch-mode power supply (SMPS) and a corresponding method for optimising efficiency of a switch-mode power supply. With respect to the closest prior art document D3, the examining division identified the following distinguishing features and formulated the following partial problems:

Distinguishing features:

A: the SMPS is a non-isolated converter
B: the converter control has an outer voltage and an inner current loop / slope compensation

C: the PWM measurement includes an averaging filter
D: an A/D converter between the measurement device and the digital control digitizes the measurement signal before sending it to the control

Partial problems

A: find other converters to apply the principle to
B: how to implement the converter control
C: how to obtain the duty cycle from the measurement
D: how to pass the measurement result to the digital controller

The appellant argued in this context that the following feature:

E: "a digital processor coupled to the PWM and having a memory, the digital processor being intended for optimizing operation of the SMPS by adjusting operating parameters of the PWM generator to provide the at least one PWM signal that produces a highest relative efficiency of the SMPS."

further distinguished the subject-matter of claim 1 from the disclosure of document D3.

Apart from the fact that the distinguishing features and partial problems as defined by the examining division do not exactly mirror the wording of the claim, the board is also not convinced that the examining division's conclusion is correct. The board therefore agrees with the appellant that the contested decision should be set aside.

2.2 Formulation of partial problems

As argued by the appellant, the reasoning in the contested decision ignores the fact that at least differentiating features C, D and E work together synergistically to solve the overall problem of providing a highly energy efficient and cost efficient SMPS solution on the basis of efficiency determinations.

In particular when examining the actual wording of claim 1, instead of the distinguishing features as defined by the examining division, the board finds it immediately apparent that features C, D and E are technically interlinked and cannot be treated separately, as they were in the reasons of the contested decision.

Moreover, the partial objective problems defined in the contested decision regarding differentiating features A to D are formulated in an arbitrary manner and equally ignore the physical interactions between at least features C, D and E.

2.3 Formal aspects regarding document D3

The board is further not convinced that the contested decision actually establishes that document D3 discloses what the examining division alleges to be disclosed.

The appellant argues in this respect *inter alia* that neither the digital processor nor its functionality according to feature E as claimed in claim 1 are

disclosed in document D3. The board agrees with the appellant.

Feature E according to the new main request reads:

"a digital processor (462) having a memory, the digital processor (462) is coupled to and provides operating parameters to the PWM generator (326; 458) during operation thereof;" and
"wherein the digital processor (462) is designated for storing in the memory digital efficiency values from the digital output of the analog-to-digital converter (ADC) (470) and wherein the digital processor (462) optimizes operation of the SMPS by adjusting operating parameters of the PWM generator (326; 458) by using the stored digital efficiency values to provide the at least one PWM signal that produces a highest relative efficiency of the SMPS." (emphasis highlighting the additional features in claim 1 according to the new main request as compared to the former main request added by the board)

According to the contested decision, feature E is disclosed in document D3, "column 4, line 34 to column 5, line 24, also figures 2 - 5. Please also see figures 2, 3 as well as column 5, line 25 - column 7, line 28".

Not a single word or reference number of this very general citation reaching over many pages of text and a considerable number of figures is presented *expressis verbis* in the contested decision. In addition, none of the features of claim 1 can be found explicitly in the cited passages of document D3. Nor are the additional features of claim 1 according to the new main request disclosed in D3.

Therefore, already from a formal point of view, the board is of the opinion that the contested decision should be set aside because the reasoning in the contested decision does not contain any link between the claimed features and where these might be disclosed in the passages cited in D3, or why they might be rendered obvious. The general citation of more than four columns of text in document D3 cannot be regarded as evidence for the anticipation of any of the features of claim 1 which are allegedly disclosed there.

2.4 Substance of document D3

Moreover, also from a substantive point of view, the board considers the contested decision not to be correct.

Claim 1

2.4.1 As already pointed out by the appellant in their reply to the summons to oral proceedings before the examining division, D3 relates to a completely different approach to increasing the efficiency of a switch-mode power supply.

The cited passages of D3 *inter alia* contain the disclosure that "The apparatus and method of the present invention are particularly advantageously employed with a converter apparatus in which controller 40 is embodied in a digital control device. Such a digital control device may be manifested in control circuitry involving microprocessors or digital signal processors or a combination of such devices."

2.4.2 However, according to feature E of claim 1, a separate digital processor is required that provides operating

parameters to the PWM generator. In contrast to this aspect of the claimed subject-matter, D3 merely discloses that the PWM generator is embodied in a digital control device, which is obviously not what is claimed in claim 1, according to which the digital processor has to be connected to the PWM generator, i.e. it has to be a separate device.

Further according to D3 "Controller 40 preferably includes a control/adjust section 42 that enables controller 40 to vary drive signals D1 and D2" wherein "Drive signal D1 controls operation of synchronous rectifier SR1; drive signal D2 controls operation of synchronous rectifier SR2" (see column 4, lines 52 to 67). Thus, the variation in drive signals according to D3 refers to control signals for synchronous rectifiers and not to control signals for the PWM generator.

This then becomes even clearer, because the disclosure in D3 continues (in column 5, lines 6 to 21) that "duty cycle D (duty cycle D is established by drive signal D0) is measured by measuring unit 46, and information relating to duty cycle D is provided to control/adjust section 42 of controller 40 to adjust drive signals D1, D2 to appropriately urge converter apparatus 10 toward high power efficiency operation" and that "Preferably the signal provided via output line 44 to measuring unit 46 is applied to a drive line 50 substantially without modification". That is, D3 teaches to not even modify the PWM signal.

The gain in efficiency according to D3 is thus based on variations of the control signals for synchronous rectifiers whereas according to claim 1 the most efficient PWM signal is used to optimise the operation of the PWM generator.

2.4.3 Consequently, the board is not convinced that feature E as identified by the appellant in their statement setting out the grounds of appeal is disclosed or rendered obvious by document D3, so that the subject-matter of claim 1 is not obvious when starting from document D3. Also, for this reason, the contested decision has to be set aside. This holds true even more regarding the additional features added to feature E of claim 1 according to the new main request.

The board notes in this context that the contested decision contains no discussion of why the modification of control signals of synchronous rectifiers according to D3 should be equivalent to what is claimed in feature E of claim 1. This is even more remarkable in view of the fact that the appellant in their reply to the summons to oral proceedings before the examining division explicitly indicated that the signals according to D3 related to synchronous rectifiers such that feature E could not be disclosed in D3. However, the term "rectifier" does not appear in the corresponding section 2.2.6.1 of the contested decision.

The board has thus reached the conclusion that, contrary to the examining division's findings, the subject-matter of claim 1 is not rendered obvious starting from the disclosure of document D3.

Claim 11

2.4.4 Moreover, as also correctly pointed out by the appellant, there is no complete reasoning in the contested decision regarding the alleged lack of

inventive step of the subject-matter of independent method claim 11.

Section 2.3 of the contested decision merely cites passages of "D3 (figure 1, column 4, line 34 - column 5, line 24 as well as figures 2 to 5 and the corresponding text" and "D1: column 7, line 41 - column 9, line 45".

The only reference to the claimed method steps of claim 11 reads "With respect to averaging, see paragraph 2.1.4.3 above."

2.4.5 Obviously, independent claim 11 comprises more features than just "averaging". Thus, it is not apparent from the provided citations of documents D3 and D1 and the brief reference to another paragraph of the contested decision why the examining division has reached the conclusion that the subject-matter of claim 11 lacks an inventive step and on which considerations this conclusion is based.

Therefore, the board holds the reasoning in the contested decision regarding claim 11 to be insufficient. Moreover, since claim 11 defines a "method for optimizing efficiency of a switch-mode power supply according to one of the preceding claims" and since this method includes explicit method steps corresponding to each of the apparatus features of claim 1, the reasoning above regarding inventive step for the apparatus of claim 1 applies correspondingly to the subject-matter of claim 11. Consequently, the board has reached the conclusion that the subject-matter of claim 11 is not rendered obvious by a combination of documents D3 and D1.

3. Conclusion

For the reasons set out above, the contested decision has to be set aside.

Further, the board is satisfied that the new main request overcomes the board's objections under Article 123(2) EPC and Article 84 EPC raised in the communication under Rule 100(2) EPC and also meets the formal requirements of the EPC. The board considers the remaining prior art documents as being less relevant than D1 and D3.

However, the board notes that in claim 1 the reference sign for the power inductor should consistently be (312) instead of (316; 318), that document D3 is not mentioned as prior art in the description and that the last paragraph of the description on page 16 is not clear in the sense of Article 84 EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division with the order to grant a patent on the basis of claims 1 to 15 according to the new main request filed on 3 August 2023 and a description to be adapted.

The Registrar: The Chairman:

U. Bultmann R. Lord

Decision electronically authenticated