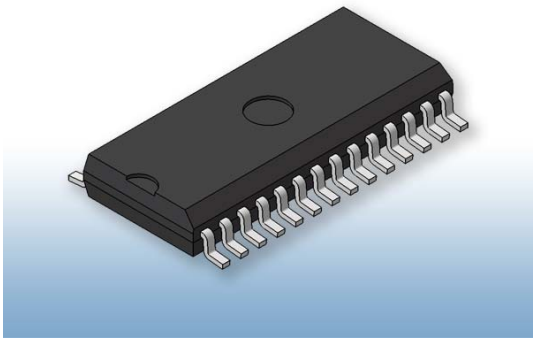
1 Introduction

The Quad Driver J12.017 is a monolithic CMOS device intended to be used as an interface circuit to ease the use of the X2x family and X6x family Stepper Motors from Juken Swiss Technology. Designed for applications in the car dashboard, the circuit allows the user to drive up to four motors as it contains four identical drivers on the same chip.
The driver circuit converts a pulse train f(scx) into a voltage level sequence sent to the motor coils. This sequence is used to produce the microstepping movement of the motor. A microstep corresponds to an angular rotation of the shaft. The microstepping allows for smooth and appealing movement of a pointer when Stepper Motor is used as pointer drive.

This device is able to drive Classic JST Stepper Motor (Example: X27) and High Torque JST Stepper Motor (Example: X65). The driving method according the family of motor (X2x or X6x) is selectable with a logic level on a specific pin MSEL.

1.1 Summary of features

- generates 24 microsteps for X2x mode (makes 1/12deg resolution on motor shaft)
- generates 48 microsteps for X6x mode (makes 1/12deg resolution on motor shaft)
- Glitch filters on all inputs
- Power Supply fully compatible 3.3V and 5V
- low EMI emission



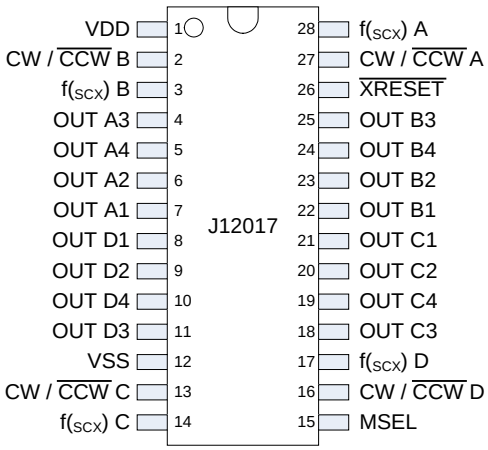
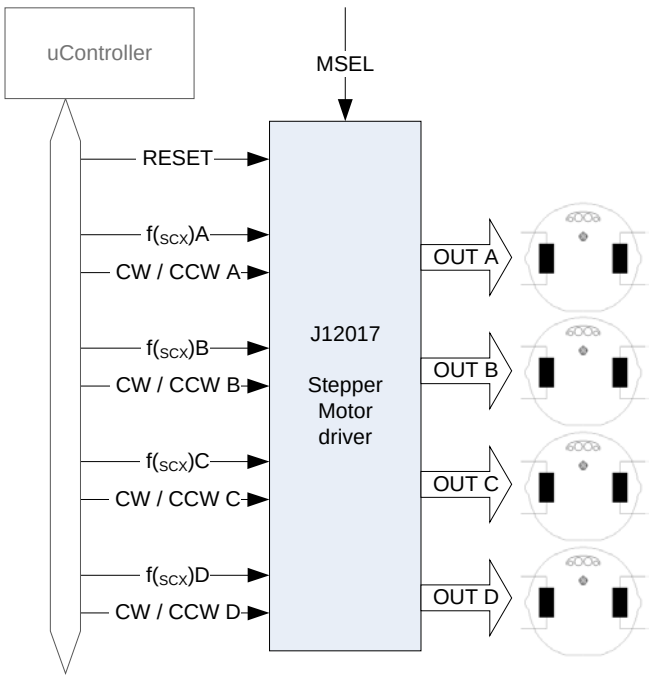


Figure 1: J12017 pinout



2 Functional description

Every driver block A to D in the device has following signals:

- “FSCXx”: The rising edge of this input signal moves the rotor by one microstep
- "CWx": The logic level of this input signal controls the direction of rotation of the motor (CW/CCW, clockwise / counter-clockwise)

- “OUTx1-4”: four output signals to connect to coil pins 1 to 4 of the stepper motor

- "XRESET": The input signal at low resets the output driver sequence to position 1
- "MSEL": The input signal to VDD selects X2x operating mode, at GND selects X6x mode

Last two signals are common to every blocks. The reset and operating mode is active for all blocks same time.

2.1 Block Diagram

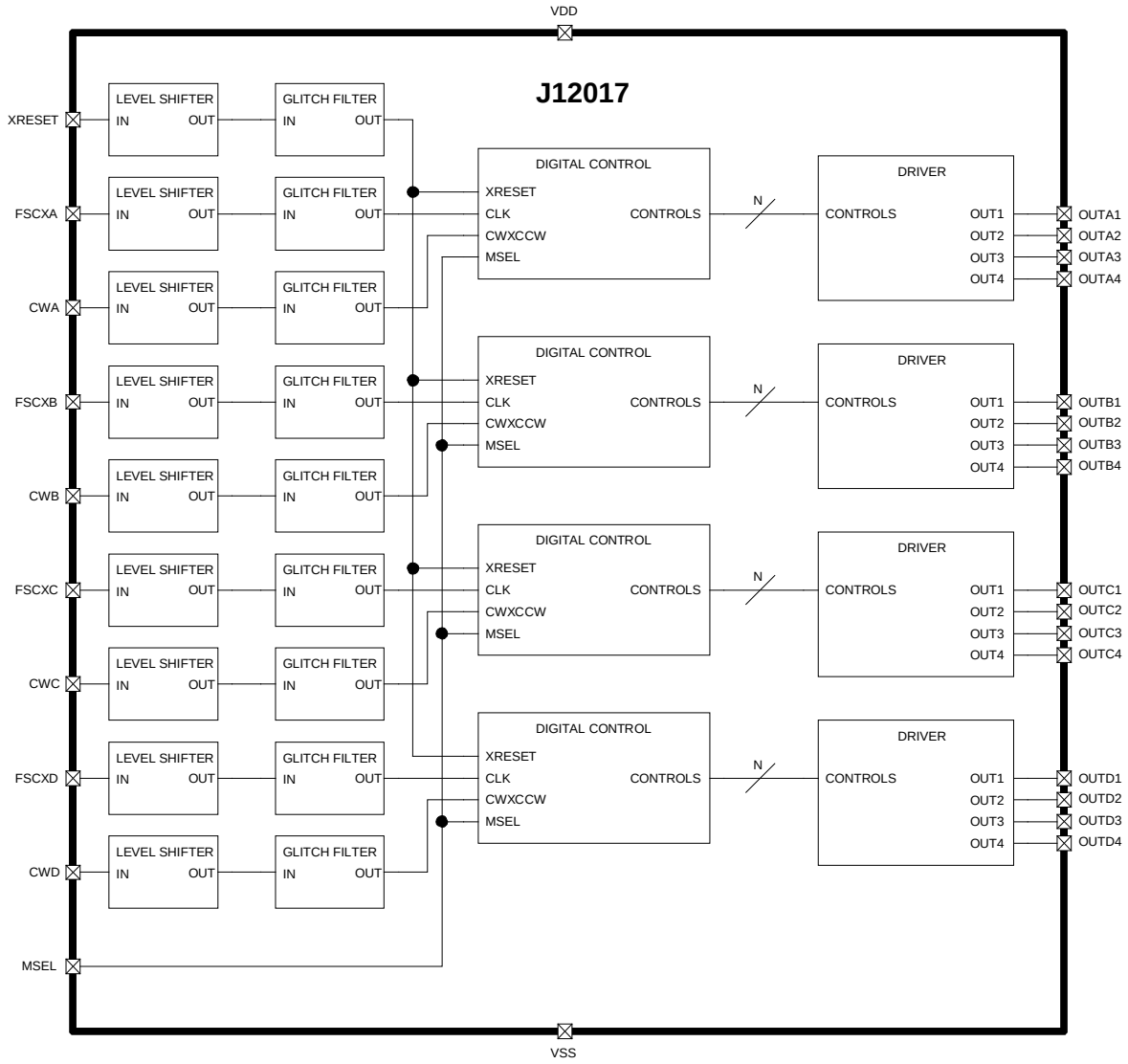


Figure 2: J12017 block diagram

2.2 Input Glitch Filter & Level Shifter

All logic inputs of the Quad Driver are armed with a glitch filter to avoid erroneous information due to spikes and glitches on the input signal lines. All negative or positive pulses of less than 20ns width are ignored. A minimum signal pulse width (positive or negative) of 100ns guarantees correct function over the full temperature range.
All logic inputs also feature a level shifter, which allows for operation of the circuit at different supply voltage (V_{DD}) than the circuits driving the inputs.

2.3 Operating Modes

The J12017 Quad Driver has two different operating modes. MSEL pin is used to select the operating mode. When MSEL is connected to VDD, the Quad Driver is in 24 steps mode for X2x family motors with 60° phase shift. If MSEL is connected to GND, the Quad Driver is in 48 steps mode for X6x family motors with 90° phase shift.
It is recommended to hold the status of MSEL when the Quad Driver is powered. Do not change the status of MSEL while Quad Driver is active.

2.4 The Output Driver

When the clock signal (FSCXx) is running the Quad Driver generates stepping signals to the motor coils at every rising edge of the clock. The output driver converts the pulse train of FSCXx into a voltage level sequence sent to the two motor coils of the Stepper Motor.

According to operating mode selected, this sequence of 24 or 48 voltage levels is used to produce the microstepping movement of rotor. The microstepping allows for smooth and appealing movement of a pointer if the Stepper Motor is used as pointer drive.

2.4.1 X2x mode output

The output driver generates 24 micro steps for a full rotation of a bipolar rotor, with a phase shift of 60°. Through the gear reduction of 1:180 for JST X27 Stepper Motor, this is transformed to an angular movement of the indicator shaft of 1/12 degree (1/12°).

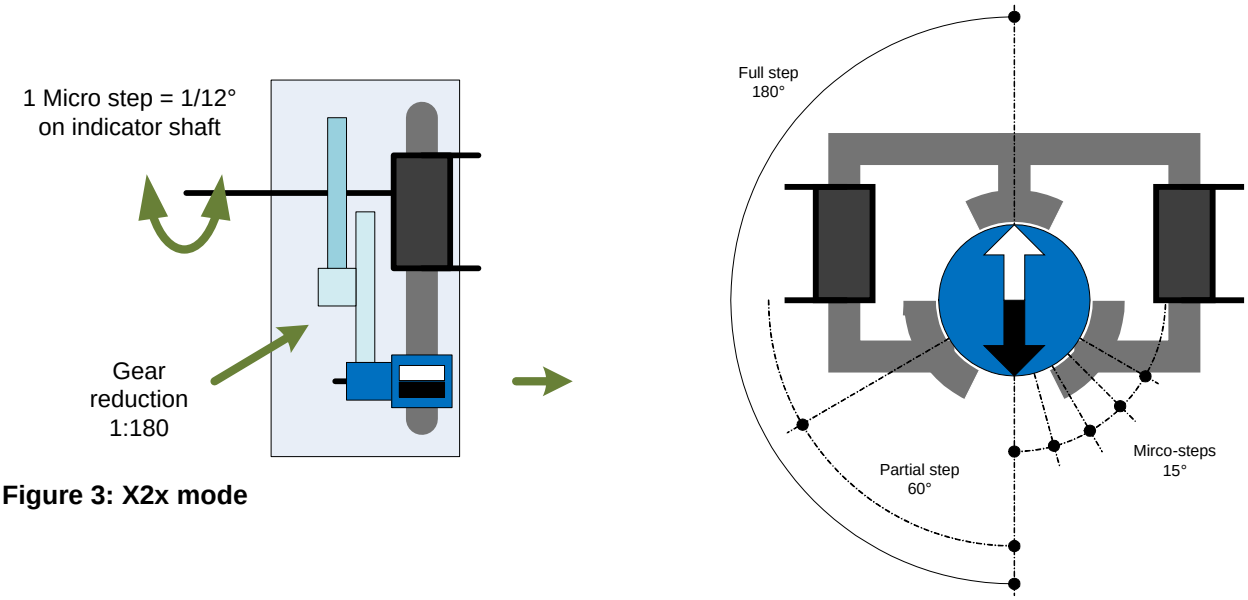


Figure 3: X2x mode

2.4.2 X6x mode output

The output driver generates 48 micro steps for a full rotation of a bipolar rotor, with a phase shift of 90°. Through the gear reduction of 1:90 for JST X65 Stepper Motor, this is transformed to an angular movement of the indicator shaft of 1/12 degree (1/12°).

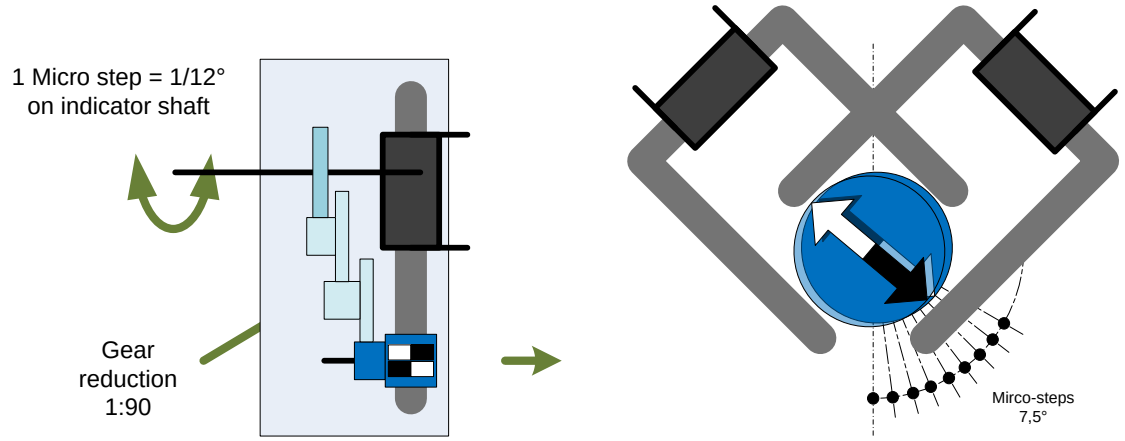


Figure 4: X6x mode

2.5 Reset function

Every time the signal XRESET is activated the output sequence in on the position 1 (out of 24 or 48, according operating mode).This is needed to synchronise controller software with Quad Driver sequence generator, for example after a power up. At the position 1 for X2x mode, both coils have same voltage levels.

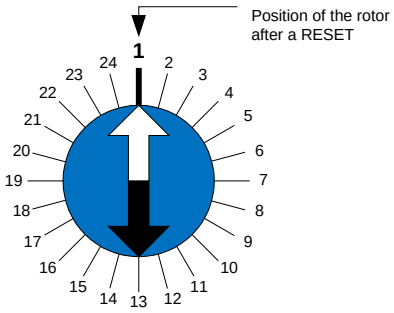


Figure 5: reset position

In order to guarantee position 1 after power up it is recommended to keep XRESET low while VDD voltage is rising. After a delay of about 1ms the XRESET can be released (i.e. set high).
Depending on the microcontroller used an external pull-down resistor (for example 10kΩ) might be required to properly set the XRESET state at low during power up.

2.6 Pin Description

Unused inputs must always be tied to a defined logic voltage level unless otherwise specified.

Pin Number	Name	I/O	Function
1	VDD	V	Supply voltage
12	VSS	V	Ground
15	MSEL	I	Mode select pin, 1-> X2x, 0->X6x
28 / 3 / 14 / 17	f(scx) A / B / C / D	I	Stepping frequency; Driver A / B / C / D
27 / 2 / 13 / 16	CW/CCW A / B / C / D	I	Direction of rotation; Driver A / B / C / D
26	RESET	I	Reset for the four drivers
7 / 22 / 21 / 8	OUT A1 / B1 / C1 / D1	O	Coil output 1; Driver A / B / C / D
6 / 23 / 20 / 9	OUT A2 / B2 / C2 / D2	O	Coil output 2; Driver A / B / C / D
4 / 25 / 18 / 11	OUT A3 / B3 / C3 / D3	O	Coil output 3; Driver A / B / C / D
5 / 24 / 19 / 10	OUT A4 / B4 / C4 / D4	O	Coil output 4; Driver A / B / C / D

Table 1: device signals

2.7 Circuit Protections

To filter fast voltage transients, it is highly recommended to connect two 100nF ceramic capacitors to the power supply pins, one on either side and as close as possible to the IC.

Moreover, to protect the IC against latch-up, a 5µF capacitor per motor connected should be added. Thus, for 4 motors, typically a 22µF capacitor must be used, either electrolytic or tantalum. Note this capacitor can be placed close to the voltage regulator.

3 Electrical characteristics

3.1 Absolute Maximum Ratings

Parameter	Symbol	Conditions
Voltage V_{DD} to V_{SS}	V_{DD}	-0.3 to +6V
Voltage at any pin to V_{DD}	V_{MAX}	+0.3V
Voltage at any pin to V_{SS}	V_{MIN}	-0.3V
Current at OUTs 1-4	I_{OUTMAX}	±40mA
Max. junction temperature	T_j	150°C
Storage temp. range	T_{STO}	-50 to +125°C

Stresses beyond these listed maximum ratings may cause permanent damage to the device. Exposure to conditions beyond specified operating conditions may affect device reliability or cause malfunction.

Table 2: Absolute maximum ratings

3.2 Handling Procedures

The device has built-in protection against high static voltages or electric fields; however,

anti-static precautions must be taken as for any other CMOS component

Unless otherwise specified, proper operation can only occur when all terminal voltages are kept within the supply voltage range.

Unused inputs must always be tied to a defined logic voltage level unless otherwise specified.

3.3 Recommended operating conditions

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Operating temperature	T_A		-40		+105	°C
Supply voltage	V_{DD}	X2x mode, 24 micro steps	4.5	5.0	5.5	V
		X6x mode, 48 micro steps	4.5	5.0	5.5	V
		X6x mode, 48 micro steps	3.0	3.0	3.6	V
Input voltage at any pin	V_{IN}		V_{SS}		V_{DD}	V

Table 3: operating conditions

3.4 Electrical Characteristics

V_{DD} = 4.5 ÷ 5.5V, T_A = -40 ÷105°C, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Power Consumption						
Quiescent supply current	I_{CC}	All inputs at V_{DD} or V_{SS}, no load		300	600	µA
Typical supply current X2x mode	I_C	1 motor 2 motors 3 motors 4 motors V_{DD}=5V, T_A=25°C, MSEL=1, R_{COIL}=260Ω		28 58 85 113		mA
Typical supply current X6x mode	I_C	1 motor 2 motors 3 motors 4 motors V_{DD}=5V, T_A=25°C, MSEL=0, R_{COIL}=195Ω		54 108 158 210		mA
Inputs						
Low level input voltage	V_{IL}	V_{DD} = 3.0 ÷ 5.5V	V_{SS}		0.8	V
High level input voltage	V_{IH}	V_{DD} = 3.0 ÷ 5.5V	2.0		V_{DD}	V

Table 4: electrical characteristics

3.5 Timing Characteristics

V_{DD} = 3.0 ÷ 5.5V, T_A = -40 ÷105°C, input signal swing V_{SS} to V_{DD}

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Signal pulse width	t_w	high or low	5			µs
Setup time to f(scx)	t_s	high or low	100			ns
XRESET release time to f(scx)	t_{rr}		100			ns
Input frequency	f(scx)	Driver input limit			24	kHz

Table 5: Timings

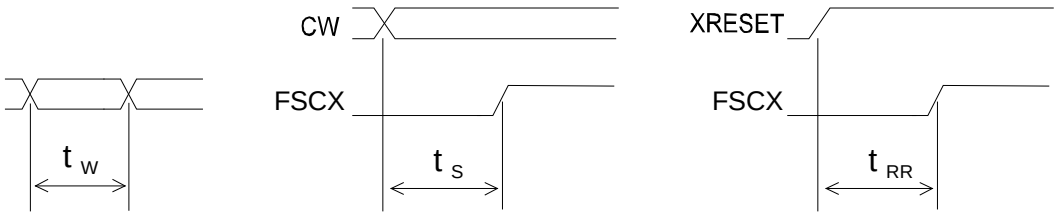
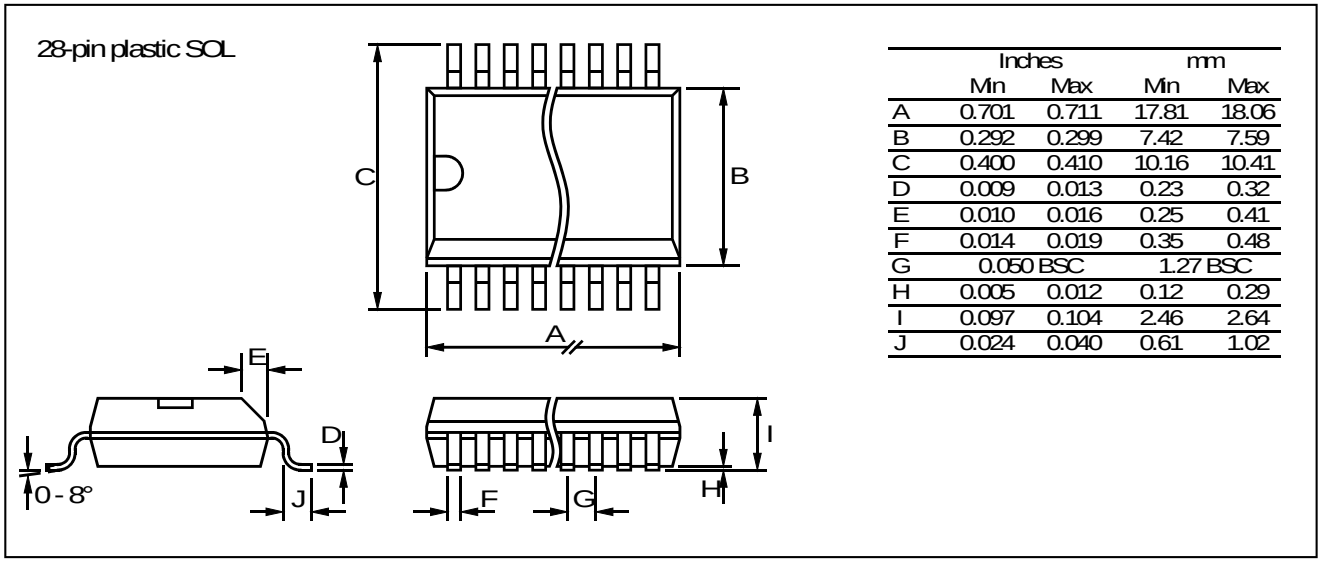


Figure 6: Delay Timing waveforms

4 Packaging

4.1 Dimensions of SOL Package

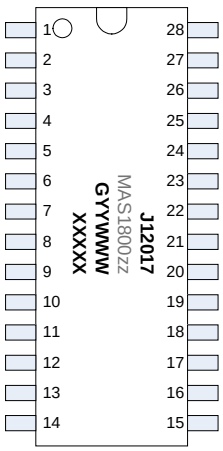


	Inches		mm	
	Min	Max	Min	Max
A	0.701	0.711	17.81	18.06
B	0.292	0.299	7.42	7.59
C	0.400	0.410	10.16	10.41
D	0.009	0.013	0.23	0.32
E	0.010	0.016	0.25	0.41
F	0.014	0.019	0.35	0.48
G	0.050 BSC		1.27 BSC	
H	0.005	0.012	0.12	0.29
I	0.097	0.104	2.46	2.64
J	0.024	0.040	0.61	1.02

Figure 7: physical dimensions

4.2 Product identification

Each Quad Driver is marked as follow:



where

zz	= version number
YYWWW	= Date Code
XXXXX	= lot number

5 Table of Index

5.1 Document history

History of document editions:			
	Creation : Date / Abbreviation	Check : Date / Abbreviation	Release : Date / Abbreviation
1st edition - A	11.02.11 / R.Esposito	11.02.11 / D. Maeder	11.02.11 / G. Nambuseril
Revision - B			
Modifications purpose			
Revision - C			
Modifications purpose			
Revision - D			
Modifications purpose			