

TLC 78/79 SIBS™ LCV1: BRAKE DESCRIPTION REV-03

Revision Control			
Rev	Released	Change	By
1	02/09/2004	Initial release	AM
2	05/10/2005	Update to cover 78/79 series Toyota Landcruisers.	AM
3	07/07/2006	Update to cover the EMMA design with a filter element (02-1007-0)	MP

## TLC 78/79 SIBS™ LCV1: BRAKE DESCRIPTION

SIBS™ (Sealed Integrated Braking System) are sealed disc brakes. The brakes consist of inner and outer housings that enclose a floating rotor and contain SIBS™ oil. Brake pistons are incorporated into the inner housing. Pads are installed in the inner and outer housings. Brake force from the pistons is applied to the floating rotor and opposed by the outer housing. Applied torque is transmitted to the hub via a spline.

The sophisticated retrofit kit replaces all original brakes and includes a new park brake actuation system. The kit includes all components required to ensure ease of fitment and a well-developed manual.

Front brakes provide service braking alone, while rear brakes provide service and parking brakes. Service brake actuation utilises existing vehicle plumbing and a new master cylinder.

The two front units contain four brake pistons to facilitate service braking. The two rear units have two service pistons and four differential pistons that make up the park brake. The brake master cylinder actuates the service pistons. The park brake is a Electronically Modulated/Mechanically Applied (EMMA™) system, in which the differential pistons are engaged by four packs of Belleville disc springs, and released via hydraulic pressure opposing the spring force. The hydraulic pressure is provided by an electrically driven hydraulic pump via an EMMA™ control module.

The EMMA™ brakes are disengaged by the brake release switch inside the cabin. This action requires the ignition to be switched on. If necessary, the ignition requirement can be by-passed with an ignition override button – pressure must be maintained on this button for continued brake release. This is incorporated for vehicle movement in exceptional circumstances and not intended for normal use.

A facility is also provided to connect the EMMA™ brakes to an interlock device. An example of this is that the brakes automatically apply should the operator open the door.

There are several advantages to the SIBS™ design:

- Sealed construction excludes the ingress of highly abrasive materials between the pad and rotor, dramatically reducing wear

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- Brake surface temperatures are maintained below 150°C
- Wet friction enables minimal wear levels of brake pads and rotor
- Worn friction material is contained within the brakes and does not pollute the environment
- The EMMA™ brake system is a fail-safe design, whereby the EMMA™ brakes apply when any of the following occur: ignition is switched off, electrical failure or in the event of park brake hydraulic line failure.

## Systems

### Common to both service and EMMA™ brakes:

SIBS™ casing, SIBS™ oil, brake pads, floating rotor and wheel hub.

### Service brake:

Hydraulic actuation: Brake pedal, and hydraulic circuit (primary and secondary), load sensing proportioning valve (rear circuit) – all existing Toyota, new master cylinder supplied with kit.

Service brake: Service pistons and seals.

### EMMA™ brake:

Alternative EMMA™ design (02-1007-0) starting with brake set serial no.:

SB 01/78 - A - 0406 - 0420.

- To improve reliability of the EMMA manifold, the following design modifications were made:
  - Filtration was incorporated into the manifold (currently external)
  - One solenoid valve was removed.

We have tested this and approved the design base on the following:

- The 'feel' of the park brake is good. There is a small delay in application at standstill, which can be reduced by adjusting the relief valve.
- The brake release time is almost instantaneous making hill starts straightforward.
- The TLC79 series with this system fitted recently passed ADR3501 testing.
- Brake release time for the 'soft stop' is faster with the new EMMA manifold over the existing production manifold.
- No 'hard stop' application is available. If required, the relief valve can be adjusted down to provide a 'hard-stop' only (may be preferred by some underground operators)
- The manifold includes a 30micron filter to prevent damage or failure due to particulate ingress, and a further screen to protect the delicate solenoid valve

**Design:**

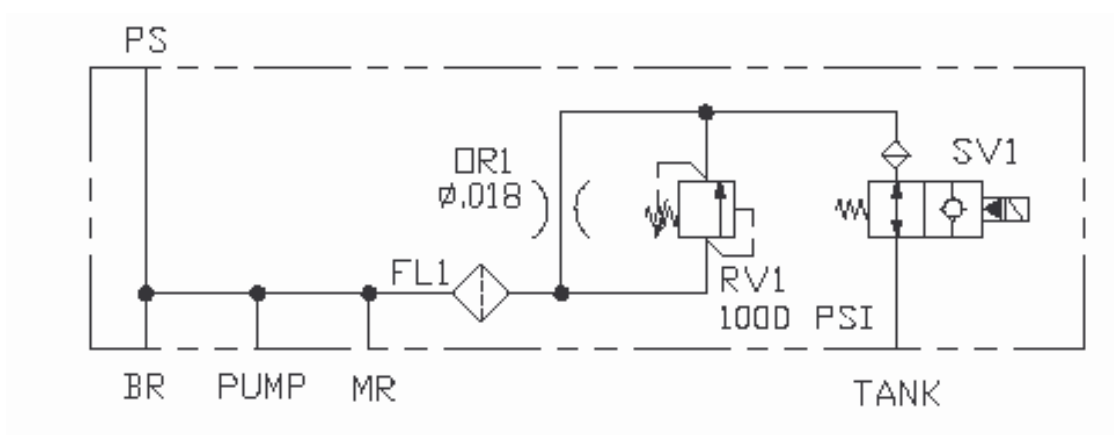
The new manifold differs from the existing production manifold in the following ways:

- Direct acting relief valve has larger flow rating
- Removes one solenoid valve (SVA)

**Functionality:**

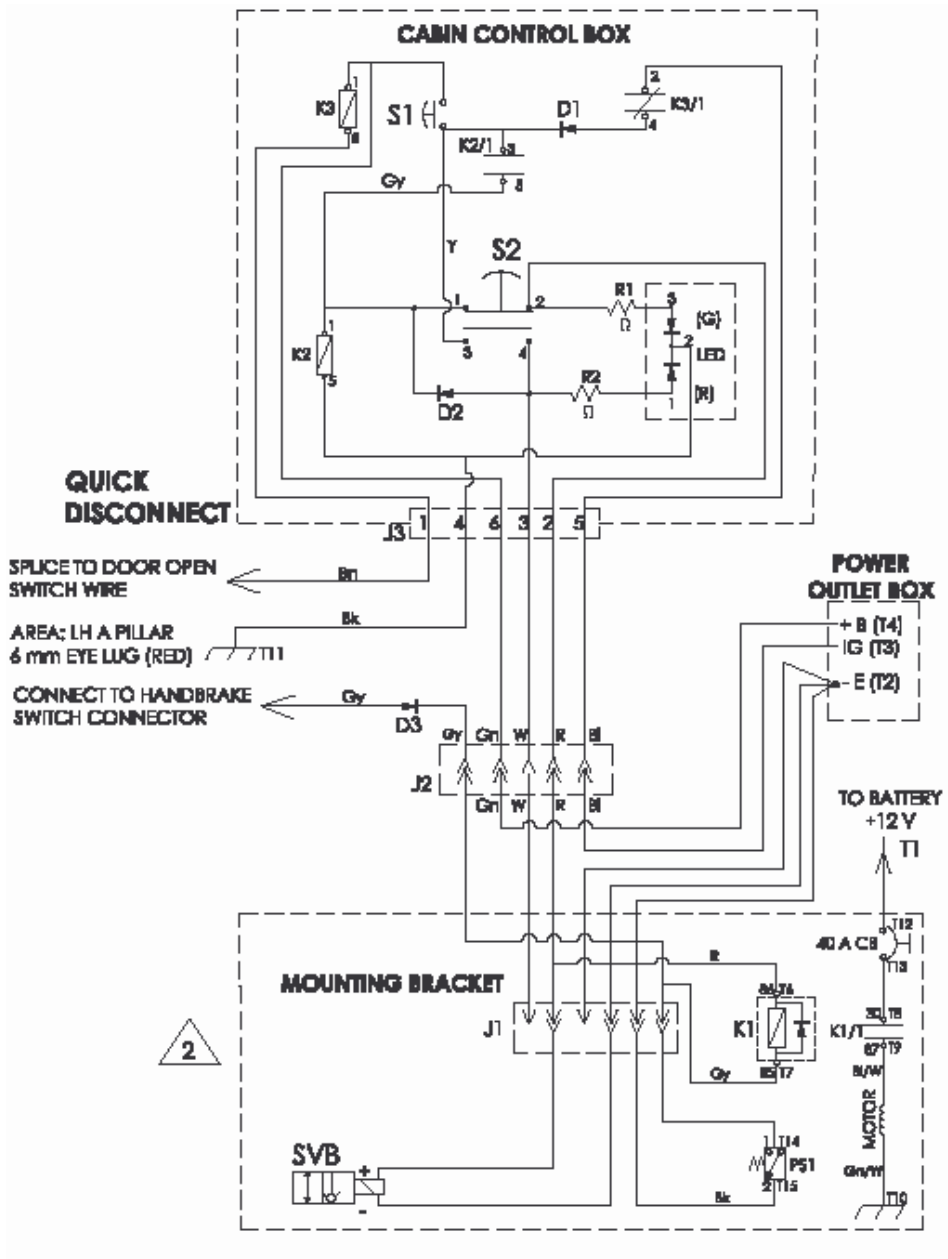
- New manifold incorporates 'soft' stop only.
- This option provides the least 'risk'
- Door interlock available.
- Relief valve can be adjusted such that the brakes come on with minimum delay if required.

EMMA™ brake: alternative hydraulic circuit diagram:



EMMA™ brake: alternative Electrical circuit diagram:

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Old design (02-1004-1)

Hydraulic actuation: Hydraulic pump, 12V electric motor, hydraulic circuit

Park Brake: Differential pistons, seals, Belleville disc springs.

EMMA™ control module:

- In cabin: EMMA™ brake release switch, ignition override switch red 'PARK BRAKE REQUESTED ON' LED and green 'PARK BRAKE REQUESTED OFF' LED, brake state indication via existing 'BRAKE WARNING' light in vehicle dashboard, and interlocking device

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- Control module: Pressure switch, throttle/flow restrictor, pressure relief valve, solenoid operated check valve (normally open), solenoid operated valve (normally closed),

## Operation of EMMA™ brake system

Refer to hydraulic and electrical diagrams below.

### Brake release

Pressure to release the EMMA™ brakes is provided by an electrically driven hydraulic pump.

- The ignition must first be switched on
- The brake switch is moved to the RELEASED position. This opens solenoid valve A (SVA) and closes solenoid valve B (SVB). Hydraulic pressure from the pump, will build in the EMMA™ brake circuit.
- Operator indication is provided by the LED in the operator control console, which indicates what brake state has been requested by the operator. The state of the brakes is indicated by the dashboard 'BRAKE WARNING' light.
- When the pressure is sufficient the EMMA™ brakes will fully release. A pressure switch, set to this release pressure, turns off the motor and the dashboard 'BRAKE WARNING' light. The dashboard 'BRAKE WARNING' light is connected to prevent the operator from attempting to drive away when the EMMA™ brakes are still applied.
- A pressure relief valve prevents the circuit from experiencing excessive pressure
- A check valve maintains the pressure in the EMMA™ circuit after the pump stops operating

### Brake application

- The brake switch is moved to the ON position, deactivating solenoid valve B (SVB) to return to its normally open position, and activating solenoid valve A to the open position. This dumps the pressure from the EMMA™ circuit and applies the brakes. The green 'PARK BRAKE REQUESTED OFF' LED is turned off and the red 'PARK BRAKE REQUESTED ON' LED is illuminated. As the pressure drops the pressure switch will turn the dashboard 'BRAKE WARNING' light ON.

### Secondary systems

- In order to move the vehicle without the ignition key, and ignition override button is provided in the cabin controls. This switch is sprung open and must be held closed for the duration of operation. This is to ensure the ignition is not routinely by-passed. Once closed the brakes will function as described previously. Should the switch be released at any time, the brakes will re-apply.

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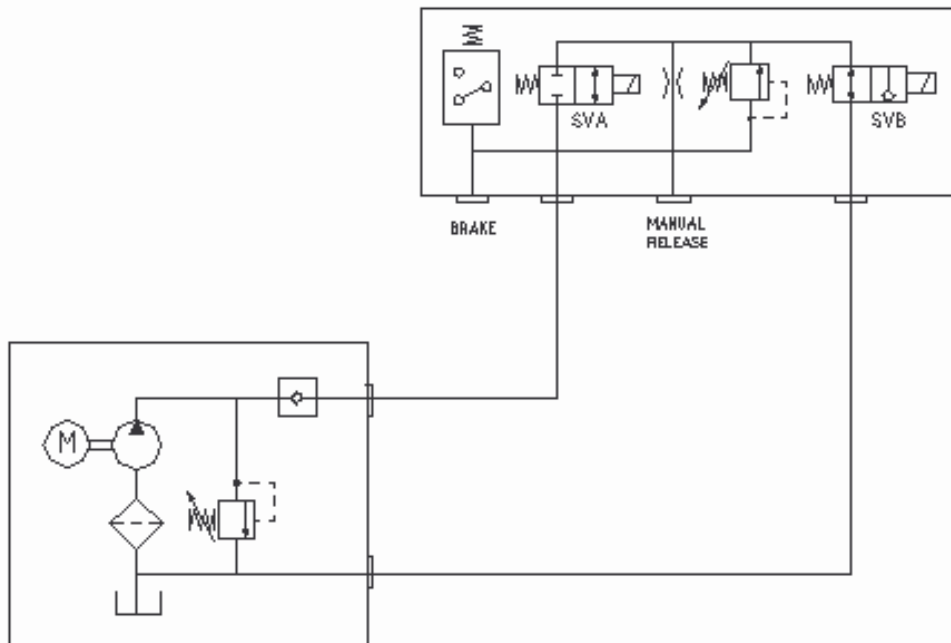
- This is incorporated for vehicle movement in exceptional circumstances and is not intended for use in conjunction with driving.

**Brake interlock**

- A facility to connect the EMMA™ brake to an interlock is provided. An example of this is that the brakes automatically apply should the operator open the door.
- When the interlocking device is triggered, the solenoid valve B (SVB) is de-energised and moves to the normally open position. EMMA™ pressure is slowly released through the pressure relief (dump) valve. This modulates the automatic brake application.
- The pressure relief (dump) valve should be individually set for average vehicle mass and road conditions to prevent unwanted wheel locking.
- Following interlock operation, the brake switch MUST be placed in the BRAKE ON position before brake release is possible.

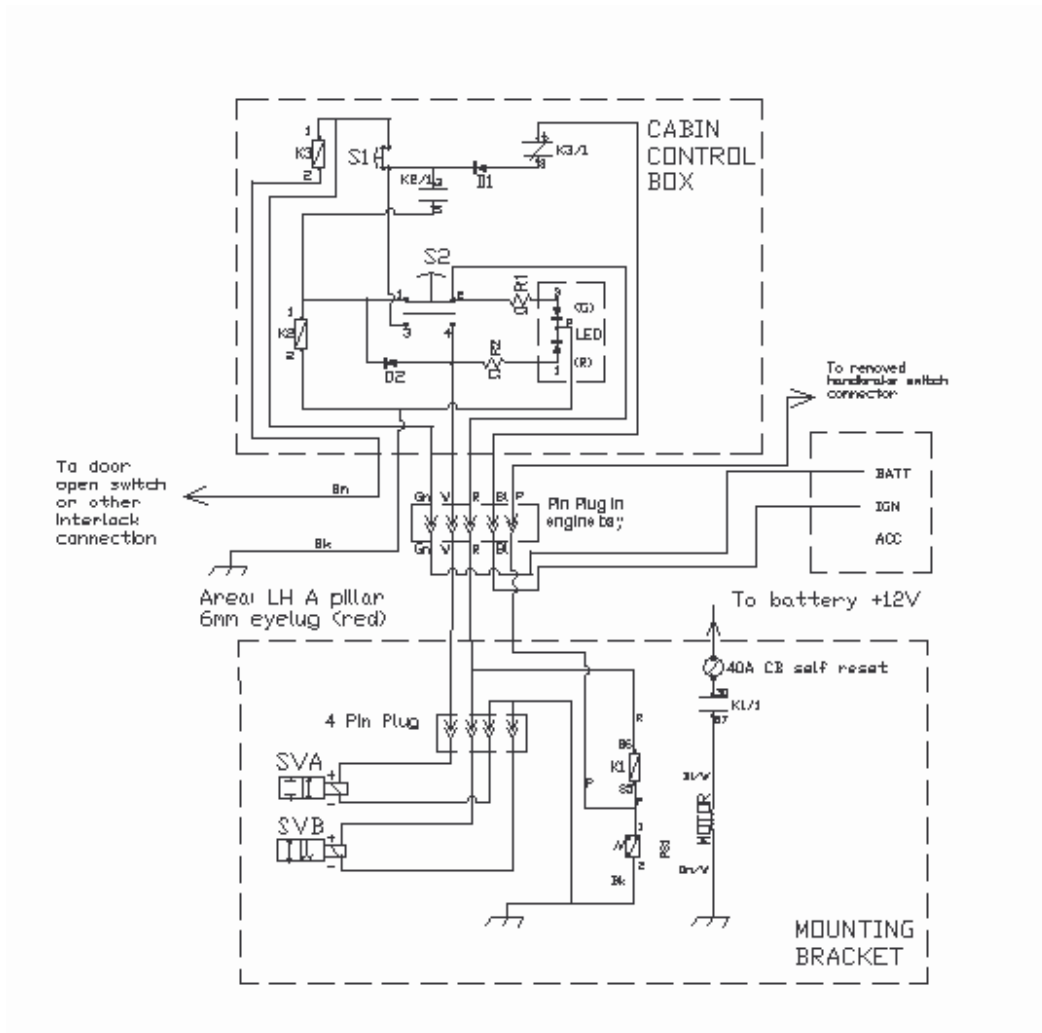
**Failure modes**

- Hydraulic leak: should there be a leak in the hydraulic system when the EMMA brake is OFF, the pressure switch will trip the pump to switch ON. This will prevent any unwanted brake application.
- Power loss: a loss of power will initiate a modulated brake application, as the pressure in the EMMA brake dumps via the relief valve and orifice valve. This will ensure a safe stop



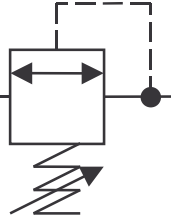
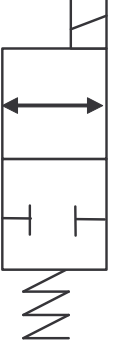
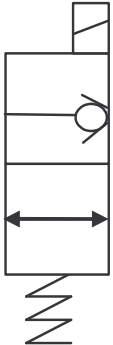
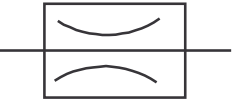


EMMA™ brake: hydraulic circuit diagram.

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EMMA™ brake: electrical circuit

## APPENDIX 1 – Hydraulic Components

Component	Symbol
Pressure relief valve	
Solenoid operated valve, normally closed.	
Solenoid operated check valve, normally open.	
Throttle / Flow restrictor	
Pressure switch	
Check valve	

## APPENDIX 2: Risk definitions<sup>1</sup>

### Qualitative measures of consequence or impact

Level	Descriptor	Example detail description
1	Insignificant	No injuries, low financial loss
2	Minor	First aid treatment, on-site release immediately contained, medium financial loss
3	Moderate	Medical treatment required, on-site release contained with outside assistance, high financial loss
4	Major	Extensive injuries, loss of production capability, off site release with no detrimental effects, major financial loss
5	Catastrophic	Death, toxic release off-site with detrimental effect, huge financial loss

### Qualitative measures of likelihood

Level	Descriptor	Description
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstances

### Qualitative risk analysis matrix – level of risk.

Likelihood	Consequences				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
A (almost certain)	H	H	E	E	E
B (likely)	M	H	H	E	E
C (moderate)	L	M	H	E	E
D (unlikely)	L	L	M	H	E
E (rare)	L	L	M	H	H

#### Legend:

**E: extreme risk, immediate action required**

**H: high risk, senior management attention needed**

**M: moderate risk, management responsibility must be specified**

**L: low risk, manage by routine procedures**

<sup>1</sup> AS/NZS 4360:2004 Risk Management