



SANYO Semiconductors

# DATA SHEET

## LC72725M LC72725V LC72725NV

CMOS IC  
— RDS Demodulation IC

### Overview

The LC72725 is an RDS (Radio Data System) signal demodulation IC. This IC integrates a bandpass filter, the demodulation circuit, and buffer RAM on a single chip and can read out RDS data in slave mode operation with the provision of an external clock input. It also supports master mode, in which the data is read out in synchronization with an RDS clock output provided by the IC itself.

### Functions

- Bandpass filter: Switched capacitor filter (SCF)
- RDS demodulation: Functions include 57kHz carrier regeneration, clock regeneration, biphasic decoding, and differential decoding
- Buffer RAM: Stores 128 bits (about 100 ms) of data.
- Data output: Output can be switched between master mode and slave mode readout.
- RDS ID detection: Supports ID reset
- Standby control: Stops the crystal oscillator.
- Low voltage: 2.7 to 5.5 V (LC72723: 4.5 to 5.5 V)
- Improvement sample in crystal oscillation capability: LC72725NV
- Fully adjustment free.

### Ratings

- Operating supply voltage: 2.7 to 5.5 V
- Operating temperature: -20 to +70°C
- Packages: MFP16 and SSOP16 (LC72723: DIP 16 and MFP16)

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**SANYO Electric Co.,Ltd. Semiconductor Company**

TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110-8534 JAPAN

## Specifications

**Absolute Maximum Ratings** at  $T_a = 25^\circ\text{C}$ ,  $V_{\text{SSD}} = V_{\text{SSA}} = 0\text{ V}$ .

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{\text{DD max}}$	$V_{\text{DDd}}, V_{\text{DDa}}^*$	-0.3 to +7.0	V
Maximum input voltage	$V_{\text{IN1 max}}$	TEST, MODE, RST	-0.3 to +7.0	V
	$V_{\text{IN2 max}}$	XIN, RDCL	-0.3 to $V_{\text{DDd}} + 0.3$	V
	$V_{\text{IN3 max}}$	MPXIN, CIN	-0.3 to $V_{\text{DDa}} + 0.3$	V
Maximum output voltage	$V_{\text{O1 max}}$	RDS-ID (READY)	-0.3 to +7.0	V
	$V_{\text{O2 max}}$	XOUT, RDDA, RDCL	-0.3 to $V_{\text{DDd}} + 0.3$	V
	$V_{\text{O3 max}}$	FLOUT	-0.3 to $V_{\text{DDa}} + 0.3$	V
Maximum output current	$I_{\text{O1 max}}$	XOUT, FLOUT, RDDA, RDCL	+3.0	mA
	$I_{\text{O2 max}}$	RDS-ID (READY)	+20.0	mA
Allowable power dissipation	$P_{\text{d max}}$	$(T_a \leq 85^\circ\text{C})$	MFP16 : 140	mW
			SSOP16 : 100	mW
Operating temperature	$T_{\text{opr}}$		-20 to +70	$^\circ\text{C}$
Storage temperature	$T_{\text{stg}}$		-40 to +125	$^\circ\text{C}$

\*: Note that  $V_{\text{DDa}}$  must be less than or equal to  $V_{\text{DDd}} + 0.3\text{ V}$

**Allowable Operating Ranges** at  $T_a = -20$  to  $+70^\circ\text{C}$ ,  $V_{\text{SSD}} = V_{\text{SSA}} = 0\text{ V}$ ,  $V_{\text{DDd}} = V_{\text{DDa}}$ .

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage	$V_{\text{DD}}$	$V_{\text{DDd}}, V_{\text{DDa}}: V_{\text{DDd}} = V_{\text{DDa}}$	2.7		5.5	V
High-level input voltage	$V_{\text{IH1}}$	TEST, MODE, RST	$0.7 V_{\text{DDd}}$		6.5	V
	$V_{\text{IH2}}$	RDCL	$0.7 V_{\text{DDd}}$		$V_{\text{DDd}}$	V
Low-level input voltage	$V_{\text{IL}}$	TEST, MODE, RST, RDCL	0		$0.3 V_{\text{DDd}}$	V
Output voltage	$V_{\text{O1}}$	RDDA, RDCL			$V_{\text{DDd}}$	V
	$V_{\text{O2}}$	RDS-ID (READY)			6.5	V
Input amplitude	$V_{\text{IN}}$	MPXIN: $f = 57 \pm 2\text{ kHz}$	1.6		50	mVrms
	$V_{\text{XIN}}$	XIN	400		1500	mVrms
Guaranteed oscillator operating range	Xtal	XIN, XOUT: $C_1 \leq 120\ \Omega$		4.332		MHz
Crystal oscillator frequency deviation	TXtal	XIN, XOUT: $F_0 = 4.332\text{ MHz}$			$\pm 100$	ppm
RDCL setup time	$t_{\text{CS}}$	RDCL, RDDA	0			$\mu\text{s}$
RDCL high-level time	$t_{\text{CH}}$	RDCL	0.75			$\mu\text{s}$
RDCL low-level time	$t_{\text{CL}}$	RDCL	0.75			$\mu\text{s}$
Data output time	$t_{\text{DC}}$	RDCL, RDDA			0.75	$\mu\text{s}$
READY output time	$t_{\text{RC}}$	RDCL, READY			0.75	$\mu\text{s}$
READY low-level time	$t_{\text{RL}}$	READY			107	ms

## LC72725M, LC72725V, LC72725NV

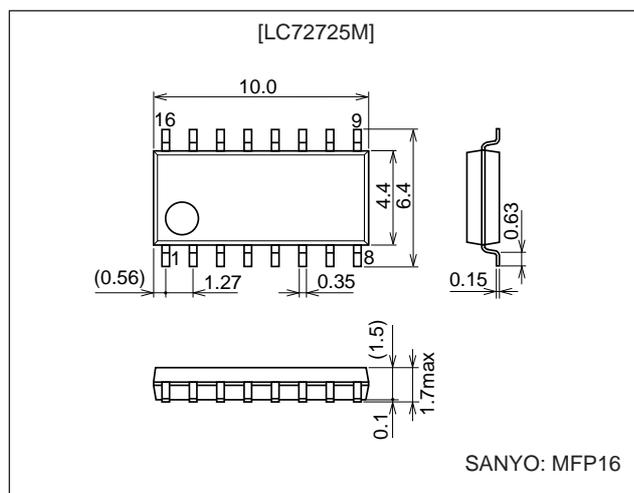
**Electrical Characteristics** at  $T_a = -20$  to  $+70^\circ\text{C}$ ,  $V_{SSD} = V_{SSA} = 0\text{ V}$ ,  $V_{DDDD} = V_{DDA}$ .

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Input resistance	Rmpxin	MPXIN-Vssa: $f = 57\text{ kHz}$		100		$\text{K}\Omega$
	Rcin	CIN-Vssa: $f = 57\text{ kHz}$		120		$\text{K}\Omega$
Internal feedback resistance	Rf	XIN		1.0		$\text{M}\Omega$
Center frequency	fc	FLOUT	56.5	57.0	57.5	$\text{kHz}$
-3dB bandwidth	BW-3dB	FLOUT	2.5	3.0	3.5	$\text{kHz}$
Gain	Gain	MPXIN-FLOUT: $f = 57\text{ kHz}$	28	31	34	$\text{dB}$
Stop band attenuation	Att1	FLOUT: $\Delta f = \pm 7\text{ kHz}$	30			$\text{dB}$
	Att2	FLOUT: $f < 45\text{ kHz}, f > 70\text{ kHz}$	40			$\text{dB}$
	Att3	FLOUT: $f < 20\text{ kHz}$	50			$\text{dB}$
Reference voltage output	Vref	Vref: $V_{DDA} = 3\text{ V}$		1.5		$\text{V}$
Hysteresis	$V_{\text{HIS}}$	TEST, MODE, RST, RDCL		$0.1 V_{\text{DDDD}}$		$\text{V}$
Low-level output voltage	$V_{\text{OL1}}$	RDDA, RDCL: $I = 2\text{ mA}$			0.4	$\text{V}$
	$V_{\text{OL2}}$	RDS-ID (READY): $I = 8\text{ mA}$			0.4	$\text{V}$
High-level output voltage	$V_{\text{OH}}$	RDDA, RDCL: $I = 2\text{ mA}$	$V_{\text{DDDD}} - 0.4$			$\text{V}$
High-level input current	$I_{\text{IH1}}$	TEST, MODE, RST, RDCL: $V_1 = 6.5\text{ V}$			5.0	$\mu\text{A}$
	$I_{\text{IH2}}$	XIN: $V_1 = V_{\text{DDDD}}$	2.0		11	$\mu\text{A}$
Low-level input current	$I_{\text{IL1}}$	TEST, MODE, RST, RDCL: $V_1 = 0\text{ V}$			5.0	$\mu\text{A}$
	$I_{\text{IL2}}$	XIN: $V_1 = 0\text{ V}$	2.0		11	$\mu\text{A}$
Output off leakage current	$I_{\text{OFF}}$	RDS-ID (READY): $V_O = 6.5\text{ V}$			5.0	$\mu\text{A}$
Current drain	Idd	$V_{\text{DDDD}} + V_{\text{DDA}}$ ( $V_{\text{DDDD}} = V_{\text{DDA}} = 3\text{ V}$ )		5		$\text{mA}$

## Package Dimensions

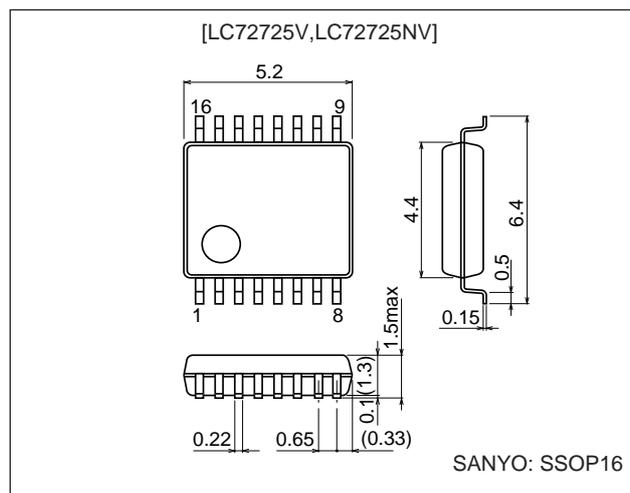
unit: mm

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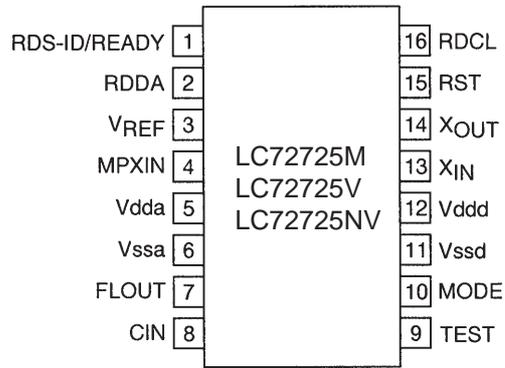
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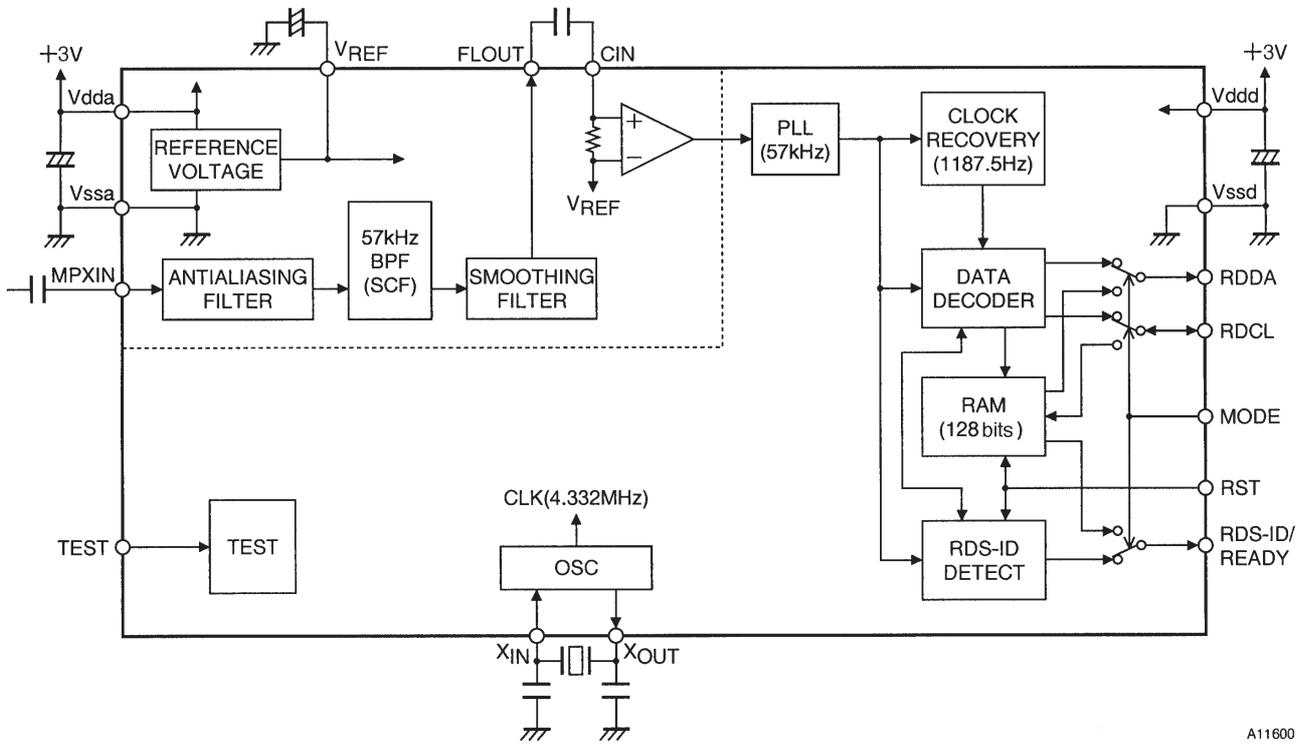
# LC72725M, LC72725V, LC72725NV

## Pin Assignment (MFP16/SSOP16)



Top view

## Block Diagram



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LC72725M, LC72725V, LC72725NV

Pin Descriptions

Pin No.	Pin	Function	I/O	Pin circuit type
3	VREF	Reference voltage output (Vdda/2)	Output	
4	MPXIN	Base band (multiplex) signal input	Input	
7	FLOUT	Subcarrier output (filter output)	Output	
8	CIN	Subcarrier input (comparator input)	Input	
5	Vdda	Analog system power supply (+3 V)	—	—
6	Vssa	Analog system ground	—	—
14	XOUT	Crystal element output (4.332 MHz)	Output	
13	XIN	Crystal element input (or external reference signal input)	Input	
9	TEST	Test input		
10	MODE	Readout mode setting (0: master, 1: slave)		
15	RST	RDS ID and RAM reset (Active high logic)	Output	
2	RDDA	RDS data output		
16	RDCL	RDS clock output (master mode) RDS clock input (slave mode)	I/O	
1	RDS-ID/READY	RDS ID/ready output (Active high)	Output	
12	Vddd	Digital system power supply (+3 V)	—	—
11	Vssd	Digital system ground	—	—

**Inputs and Outputs**

TEST	MODE	Circuit operating mode	RDCL pin	RDS-ID/READY pin
0	0	Master mode	Clock output	RDS-ID output
0	1	Slave mode	Clock input	READY output
1	0	Standby mode (crystal oscillator stopped)	—	—
1	1	IC test mode (Cannot be set by users.)	—	—

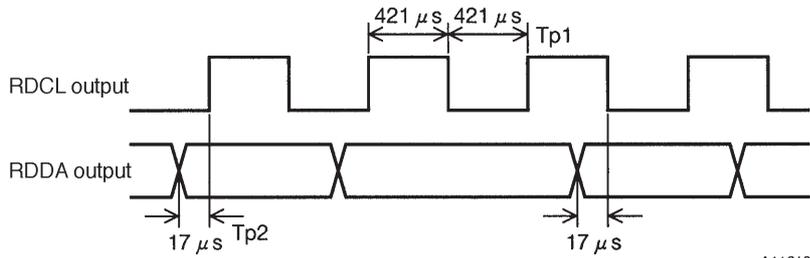
RST pin	
RST = 0	Normal operation
RST = 1	The RDS-ID and demodulation circuits are cleared, and (in slave mode) the READY state and memory are cleared.

RDS ID/READY pin	
Master mode	RDS-ID output (active high)
Slave mode	Readout data ready output (active high)

Note: The RDS-ID (READY) pin is an n-channel open-drain output, and data is read out by connecting a pull-up resistor.  
 \* LC72723: Active-low

**RDCL/RDDA Output Timing**

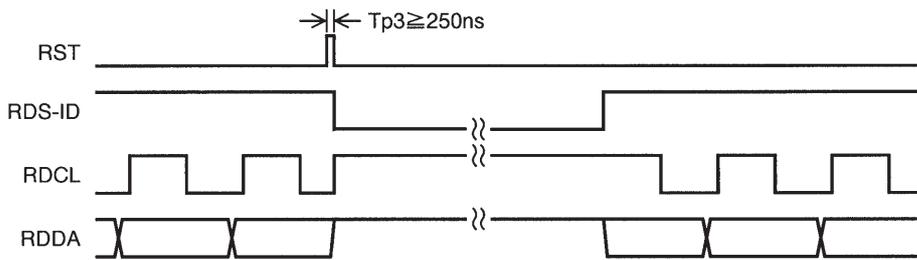
- Master mode



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**RST Operation**

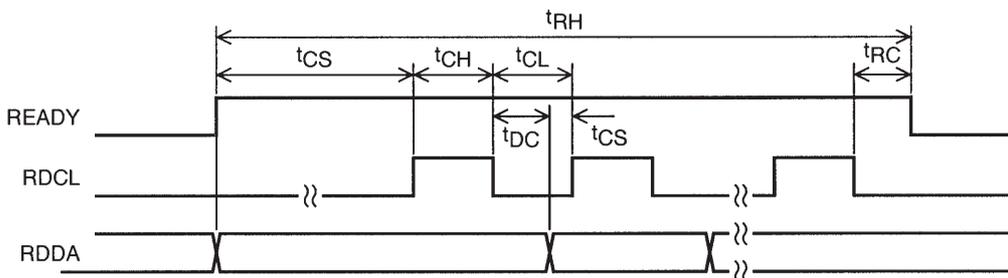
- Master mode



Caution: After an RST input, the RDCL and RDDA outputs stop at the high level until the first RDS ID detection.

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**RDCL Control in Slave Mode**

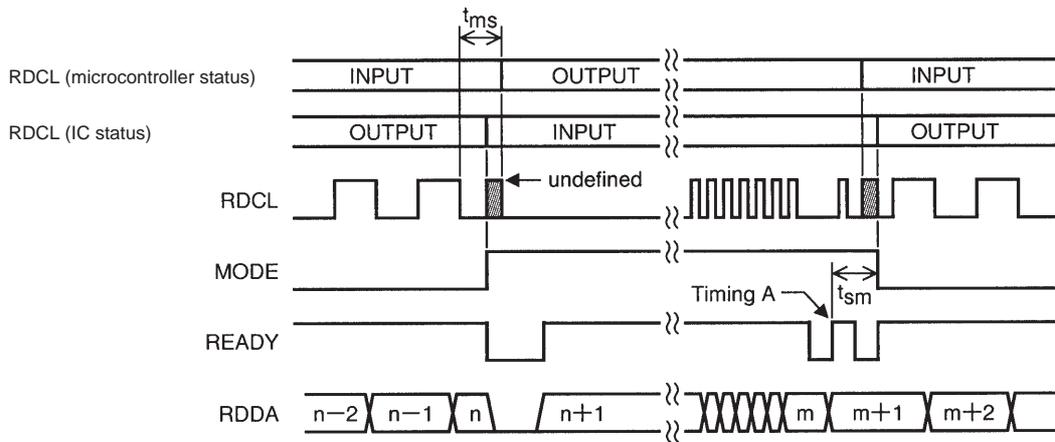


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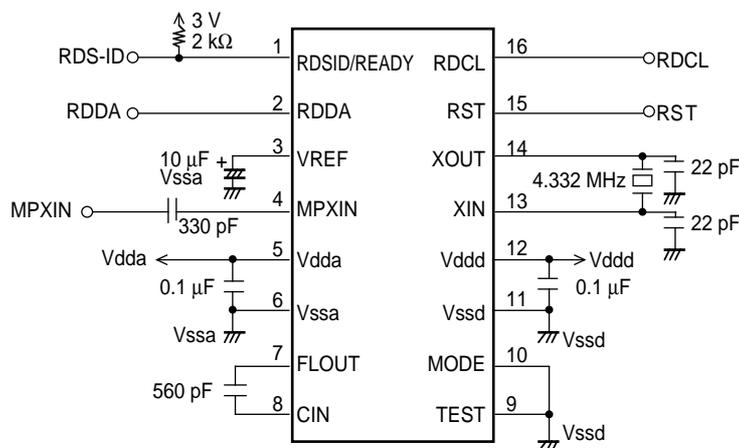
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
RDCL setup time	$t_{CS}$	RDCL, RDDA	0			$\mu\text{s}$
RDCL high-level time	$t_{CH}$	RDCL	0.75			$\mu\text{s}$
RDCL low-level time	$t_{CL}$	RDCL	0.75			$\mu\text{s}$
Data output time	$t_{DC}$	RDCL, RDDA			0.75	$\mu\text{s}$
READY output time	$t_{RC}$	RDCL, READY			0.75	$\mu\text{s}$
Ready high-level time	$t_{RH}$	READY			107	ms

- Notes: 1. Start RDCL clock input after the READY signal goes high. Applications must stand by with RDCL held low when the READY pin is low.
2. Each time the RDCL input is switched from low to high to low, the application must check the READY signal level after the period  $t_{RC}$  has elapsed once RDCL has been set low. If READY is at the high level, the application may apply the next RDCL clock cycle. If READY is low, the application must stop RDCL input at that point.
3. When the above timing conditions are met, RDDA can be read at either the rise or fall of the RDCL signal.
4. After the last data from memory has been read, READY will be low once the period  $t_{RC}$  has elapsed after the fall of the RDCL signal. If even 1 bit of data has been written to memory, READY will be high and the application will be able to read that data.
5. When switching channels, it is desirable to immediately reset memory and the READY pin with an RST input. If this is not done, data received on the previous channel may remain in memory. When the IC is reset, data is not written until the RDS-ID is detected, and therefore, the READY signal will go high after the RDS-ID is detected. (Although the RDS-ID is not output in slave mode, it is detected internally in the IC.) After an RST input, once an RDS-ID has been detected, all received data will be written to memory regardless of the RDS-ID detection state.
6. The readout mode may be switched between master and slave modes during readout. Applications must observe the following points to assure data continuity during this operation.
- Data acquisition timing in master mode  
Data must be read on the falling edge of RDCL.
  - Timing of the switch from master mode to slave mode  
After the RDCL output goes low and the RDDA data has been acquired, the application must set MODE high immediately. Then, the microcontroller starts output by setting the RDCL signal low. The microcontroller RDCL output must start within 840  $\mu\text{s}$  (tms) after RDCL went low. In this case, if the last data read in master mode was data item n, then data starting with item n+1 will be written to memory.
  - Timing of the switch from slave mode to master mode  
After all data has been read from memory and READY has gone low, the application must then wait until READY goes high once again the next time (timing A in the figure), immediately read out one bit of data and input the RDCL clock. Then, at the point READY goes low, the microcontroller must terminate RDCL output and then set MODE low. The application must switch MODE to low within 840  $\mu\text{s}$  (tms) after READY goes high (timing A in the figure).



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LC72725 Sample Application Connection Circuit (for master mode operation)



Caution: If the RST pin is unused, it must be connected to ground.

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