

Features

- Force voltage/measure current and force current measure voltage functions
- Forced voltage range (-5V to +15V)

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- Four programmable measured current ranges: Range $A = \pm 20\mu A$ max
- Range $B = \pm 200 \mu A \max$
- Range C = ± 1.0 mA max
- Range $D = \pm 40$ mA max
- High resolution current force/measure $\pm 0.05\% = 2$ bits
- Internal control circuitry for selecting ranges
- High accuracy: 12 bit linearity and 0.5% gain error
 High current range D current limit protection set
- High current range D current limit protection set externally by the value of resistor R_{DIL}
- Measurement output voltage can be disabled
- Forced current ranges: Range A = $\pm 20\mu$ A max Range B = $\pm 200\mu$ A max Range C = ± 1.0 mA max Range D = ± 40 mA max
- Measured voltage range: -5V to +15V

- High resolution voltage measurement (±0.05%) and accuracy: (±10mV max. offset) and 0.5% gain error
- Internal current limit for ranges (A, B, & C)

Applications

- · ATE pin electronics measurements
- Instrumentation, meters
- Programmable voltage or current supply

Description

The RC7352 is a "Per Pin" Parametric Measurement Unit (PMU) that can force voltage and measure current or force current and measure voltage. The RC7352 forces voltages from +15V to -5V when +Vs is 20V and -Vs is -10V, or currents up to ±40mA. All logic inputs for the RC7352 are TTL compatible, while the open collector logic outputs are TTL/CMOS compatible.

Setting the SI/V (Select I/V) pin low puts the RC7352 in the force voltage and measure current mode. The resulting output voltage at the DUT matches the input applied to the



Block Diagram

I/VIN pin (please refer to block diagram). The I/VM pin provides a voltage proportional to the DUT current. V(I/VM) = (4 x R x I(DUT)), where R is the external range resistor (0.05% tolerance) and I(DUT) is the current supplied to the load. The resistors in the application circuit were chosen using this formula R range = (2V/Imax), for Range A this is RA = 2/20 μ A or 100K.

When SI/V is high the RC7352 will force current and measure voltage. The range select pins RS1 and RS2 control the maximum output current (see Table 1), while magnitude of the forced current is given by the expression

 $I(DUT) = V(I/VIN)/(4 \times R)$

where R is the range resistor. In the FI/MV mode the voltage at the I/VM pin equals the device voltage. The I/VM pin can be connected to an A/D convertor to monitor the current or voltage at the load device.

The RC7352 also has a window comparator that can provide upper or lower limit fail information. I/Vmx and I/Vmn are voltage inputs for the upper and lower limits respectively. You must use the formulas listed above to calculate current limits for each range while voltage limits are 1:1. Their corresponding outputs, VHF (V high fail) and VLF (V low fail) can be used individually or "Wire ORed" to obtain a composite signal. Additionally the VDIS pin can be set high to disable the window comparator and its I/O lines. Although this reduces overall power consumption, it also disables the I/VM output.

Table 1. Maximum Output Current onPin Select

SI/V	RS2	RS1	Mode
0	0	0	FV/MI Range A, Imax = $\pm 20 \ \mu A$
0	0	1	FV/MI Range B, Imax = $\pm 200 \ \mu A$
0	1	1	FV/MI Range C, Imax = ±1.0 mA
0	1	0	FV/MI Range D, Imax = ±40 mA
1	0	0	FI/MV Range A, Imax = $\pm 20 \ \mu A$
1	0	1	FI/MV Range B, Imax = $\pm 200 \ \mu A$
1	1	1	FI/MV Range C, Imax = ±1.0 mA
1	1	0	FI/MV Range D, Imax = ±40 mA

Notes:

- 1. FV/MI = Force Voltage Measure Current.
- 2. FI/MV = Force Current Measure Voltage.
- 3. $+VS-5 \ge VOUT \ge -VS+5$

Pin Assignments



Pin Description

Pin Name	Pin Number	Pin Description		
+Vs	28	+Vs should be bypassed to ground with a 10.0 μF tantalium capacitor placed as close to the pin as possible.		
-Vs	16	–Vs should be bypassed to ground with a 10.0 μF tantalium capacitor placed as close to the pins as possible.		
V _{EE}	3	V_{EE} is the negative supply for range D. This pin should be bypassed with a 0.1 μF ceramic capacitor to ground.		
GND	8	This pin should be connected to the printed circuit board's ground plane.		
I/V _{IN}	23	Input reference voltage for V_{OUT} or IOUT. In the force voltage measure current mode (FV/MI)		
		$V(I/V_{OUT}) = V(I/V_{IN})$		
		and		
		$V(I/VM) = 4 \times I_{OUT} \times R$		
		Where IOUT is the device output current and R is the range resistor.		
		In the Force Current/Measure Voltage Mode		
		$I_{OUT} = \frac{V(I/VIN)}{4 \times R}$		
		V(I/VM) = V(I/VOUT)		
I/V _{OUT}	7	The Load or Device under test is connected to I/VOUT. The current to the load is supplied via the appropriate range resistor with I/VOUT serving as the voltage feedback point for the PMUs internal instrumentation amplifier.		
SI/V	13	A TTL/CMOS signal applied to this pin selects either Force Voltage/Measure Current or Force Current/Measure Voltage mode. A TTL/CMOS low level will select Force Voltage/Measure Current function. A TTL/CMOS high level selects Force Current/ Measure Voltage mode.		
R _A	9	Resistor R_A should be placed between R_A and I/V_{OUT} . R_A tolerance should be better than +0.05% to improve gain error. Maximum current for range A is shown in the equation below.		
		$I_{A} = \frac{\pm 2V}{R_{A}}$		
		The ±2 volts represents the maximum voltage V _A across R _A . For Range A, I _A should not exceed ±20 μ A, i.e., R _A should be higher than or equal to 100 k Ω . A metal film resistor should be used to reduce inherent resistor noise (schott and pop corn noise) and improve resolution. For maximum stability, a 300 pF capacitor should be connected across R _A .		
R _B	19	For Range B, I _B should not exceed ±200 μ A, i.e., R _B should be higher than or equal to 10 k Ω with ±0.05% tolerance. For maximum stability a 1,000 pF capacitor should be connected across R _B .		
R _C	22	For Range C, I _C should not exceed ± 1 mA, i.e., R _C should be higher than or equal to 2 k Ω with $\pm 0.05\%$ tolerance.		
RD	24	For Range D, I _D should not exceed ±40 mA, i.e., R _D should be higher than or equal to 50 Ω with ±0.05% tolerance.		
D	1	Two diodes must be connected between D & R _D as shown in the block diagram.		
C _A , C _B	6, 25	A 30pF capacitor placed between these pins will improve stability.		
R _{DIL}	2	Range D output for current limiting. An external resistor is connected between RDIL and D to limit current to a value $I_{LIM} = 0.8V/R_{LM}$.		

Pin Description (continued)

Pin Name	Pin Number	Pin Description				
R _{S1} ,	12	R _{S1} and R _{S2} are TTL or CMOS compatible. The truth table below shows the range selection table.				
Rs2	14	RS1 RS2 Range Selected				
		L L A				
		L H B				
		н н с				
		H L D				
I/V _{MX} , I/V _{MN}	4 26	The voltage applied to pin 4 sets the upper current or voltage limit for the measurement at pin 15 I/VM. To set the desired limit for current measurement a voltage equaling $(4 \times I_L \times R)$ must be applied on this pin. R is the external resistor of the selected range (A, B, C, or D). For voltage measurement the voltage applied to this pin is the limit.				
V _{HF}	5	VHF, High Fail, is an open collector output that requires a pull-up to the logic supply. If the voltage at pin 15, I/VM, is greater than the threshold voltage at pin 4, I/V _{MX} , V _{HF} will become a logic low. The open collector structure makes wire-ORing of multiple PMU's possible. Connect a 3,000 pF capacitor to GND to minimize oscillation at the cross-over point.				
V _{LF}	29	VLF mirror VHF for the lower threshold I/VMN. Connect a 3,000 pF capacitor to GND to minimize oscillation at the cross over point.				
V _{DIS}	21	When V _{DIS} is tied to ground output I/VM, V _{HF} and V _{LF} are enabled. If V _{DIS} is open V _{HF} and V _{LF} will require external pullups to maintain a logic high. And I/VM will be in a high impedance state.				
I/VM	15	n the Force Voltage/Measure Current mode this output voltage is equal to four times he voltage across external resistor R of selected range A, B, C, or D through which he measured current is flowing $((I/V)_M = 4.0 \times I_M \times R)$. In the Force Current/ Measure Voltage mode this output is equal to the voltage at I/V out. This output can be disabled by applying a TTL HI on the V _{DIS} pin. (Pin 21)				
V _{FB}	20	$V_{FB},$ voltage feedback, is the buffered output voltage, I/V $_{OUT}.$ This pin should not be loaded. Connect a 50K 1% resistor from V_{FB} to CAP_V.				
RADJ	10	The RADJ pin is provided to adjust the offset for the ISENSE function. The best accuracy for V/IM is obtained when RADJ is shorted to analog ground. The point is terminated with a 100 Ω resistor in the block diagram.				
CAP_I CAP_V CA	11 18 17	CA is the common point for two 50 pF compensation capacitors that improve the stability of the PMU. These components are optional and can be omitted for some loads.				

Absolute Maximum Ratings¹

Parameter	Min.	Max.	Units
Absolute Difference, +VS+ -VS		32	V
Digital Control Inputs	•	•	
SI/V, RS ₁ , RS ₂ , V _{DIS}	-2	+6	V
Comparator Inputs	•	•	
I/V _{MN} , I/V _{MX}	I/V _{MN} ≤ +VS	–Vs ≤ I/VMX	V
I/VIN		–VS ≤I/VIN ≤ +VS	V

Notes:

1. Absolute maximum ratings are limiting values applied individually while all other parameters are within specified operating conditions. Functional operation under any of these conditions is NOT implied.

2. Applied voltage must be current limited to specified range, and measured with respect to GND.

3. Forcing voltage must be limited to specified range.

4. Current is specified as conventional current flowing into the device.

Recommended Operating Conditions

Symbol	Parameters	Min.	Тур.	Max.	Units
ТС	Case operating temperature	0		70	°C
+Vs	Positive supply voltage ¹		20.0	20.6	V
-VS	Negative supply voltage ¹		-10.0	-9.5	V
VEE	Negative supply voltage for range D ²		-Vs		V
RA	Resistor for IA current range	100		2000	KΩ
R _B	Resistor for IB current range			200	KΩ
RC	Resistor for IC current range			40	KΩ
RD	Resistor for ID current range	50		1000	Ω

Notes:

1. $+VS + |-VS| \le 30V + VS + |-VS| \ge 24$

2. -VS & VEE are always at the same voltage.

+VS = 20V ±3%, –VS = -10V ±5% TA = 25°C, and external ±0.05% tolerance resistors RA = 1000k Ω , RB = 10k Ω , RC = 2k Ω , and RD = 50 Ω unless otherwise specified.

Symbol	Parameters	Test Conditions	Min.	Тур.	Max.	Units
Forced Cu	irrent/Measure Voltage	1				
I/VIN	Input Voltage Range For Setting Forced Current (IF)	I/VFIN = 4 x IF x R	-8		+8	V
I/V _M	Measured Voltage Output @ (I/V)M	All ranges, full scale current	-5		+15	V
	Output Sink/Source Current	(I/V) _M = -5V, +15V	-200		+200	μA
Vmr	Voltage Measured Resolution		05	±0.025	+0.05	%FSR
Vor	Voltage Measurement Offset	I/VIN = 0V; Measured @ I/VM	-6.0	±2	+6.0	mV
VGE	Voltage Gain Error	Gain of 4	-2.0	+0.5	+2.0	%
CMRR ¹ IOER	IOUT Error Due to Common Mode Load Voltage	$-5V \le I/V_{OUT} \le +15V$; Measured @ (I/V) _M	45	60		dB
Forced Vo	Itage/Measure Current	•				
I/VIN	Force Input Voltage Range	All ranges, full scale current	-5		+15	V
I/VFvos	Forced Voltage Offset	I/VIN = 0V, measure I/VOUT and VFB	-6.0	±2	+6.0	mV
	Forced Voltage Linearity Error			±0.025	±0.05	FSR%
CMRR ² VLER	IOUT Measure Error Due to I/VM Common Mode Voltage	-FSR \leq I _{OUT} \leq +FSR; Measured @ (I/V) _M	45	60		dB
I/Vout	Forced Output Voltage Range	All ranges, full scale current	-5		+15	V
I/VM	Voltage Output Equivalent to Measured Current: $(I/V)_M = 4 \times I_F \times R$	All ranges, full scale voltage	-8		+8	V
1	I measured; $I = (I/VM)/(4R)$	$I/V_{M} = -8.0V, +8.0V;$ full scale	-200		+200	μΑ
Current R	anges	•	•			
Range A						
IA	Maximum Full Scale Current	R _A = 100kΩ (0.05%)			±20	μΑ
IAMR	Current Measurement Resolution	guaranteed by design		±0.025		%
ILIN	Linearity ³		-0.05	±0.025	+0.05	
IGE	Current Gain Error ⁴		-2.0	0.5	+2.0	%
IFIOS	Force Current Offset ⁵	I/VIN = 0V	-25	±10	+25	nA
IMIOS	Measure Current Offset ⁶	I/VIN = 0V	-25	±10	+25	nA
Range B						
IB	Maximum Full Scale Current	R _B = 10kΩ (0.05%)			±200	μΑ
IBMR	Current Measurement Resolution	guaranteed by design		±0.025		%
ILIN	Linearity ³		-0.05	±0.025	+0.05	
IGE	Current Gain Error ⁴		-2.0	±0.5	+2.0	%
IFIOS	Force Current Offset ⁵		-250	±100	+250	nA
IMIOS	Measure Current Offset ⁶		-250	±100	+250	nA

DC Electrical Characteristics (continued)

Symbol	Parameters	Test Conditions	Min.	Тур.	Max.	Units
Range C	Range C					
IC	Maximum Full Scale Current	R _C = 2kΩ (0.05%)			±1	mA
ICMR	Current Measurement Resolution	guaranteed by design		±.025		%
ILIN	Linearity ³		-0.05	±.025	+0.05	%
IGE	Current Gain Error ⁴		-2.0	±0.5	+2.0	%
IFIOS	Force Current Offset ⁵		-1.5	±0.5	+1.5	μΑ
IMIOS	Measure Current Offset ⁶		-1.5	±0.5	+1.5	μΑ
Range D						
IC	Maximum Full Scale Current	$R_{D} = 50\Omega (0.05\%)$			±40	mA
IDMR	Current Measurement Resolution Current Measurement Accuracy	guaranteed by design		±.025		%
ILIN	Linearity ³		-0.05	±.025	+0.05	%
IGE	Current Gain Error ⁴		-2.0	±0.5	+2.0	%
IFIOS	Force Current Offset ⁵		-50	±20	+50	μΑ
IMIOS	Measure Current Offset ⁶		-50	±20	+50	μΑ
Digital Co	Digital Control Inputs (SI/V, RS ₁ , RS ₂)					
Vih	Internal Threshold Voltage		0.8	1.4	2.0	V
ILH	Logic High Bias Current	VH = 2.0V		200		nA
ILL	Logic Low Bias Current	VL = 0.8V		2.0		nA
Digital Co	Digital Control Input V _{DIS}					
VIH	Internal Threshold Voltage		0.8	1.4	2.0	V
ILH	Logic High Bias Current	VH = 2.0V		1.0		μA
ILL	Logic Low Bias Current	VL = 0.8V		2.0		nA
Comparat	or Input; I/V _{MAX} , I/V _{MIN}					
I/VMX,MN	Input Voltage Range		-8.0		+15	V
Ін	Input Bias Current (Logic High)	VH = +15V		0.4		μΑ
IL	Input Bias Current (Logic Low)	VL = 0.8V		0.4		μA
Comparat	or Status Outputs; V _{HF} , V _{LF}					
Voh	Output Voltage (Logic High)	$RPULLUP = 10k\Omega$	3.5			V
Vol	Output Voltage (Logic Low)	$RPULLUP = 10k\Omega$			0.8	V
ЮН	Output Current High	Vout = 5.0V		0.1		μA
IOL	Output Current Low				1.0	mA
Iz	Output Leakage Current Disable State	VOUT = 5.0V		0.1		μA
Other						
l+ (1.0)	Positive Supply Current	No load Range A		4.0	11.0	mA
I- (2.0)	Positive Supply Current	No load Range A		4.0	11.0	mA

Notes:

$$\mathsf{CMRR} = 20 \log \left(\frac{\Delta \mathsf{I}_{\mathsf{OUT}} \times 4 \times \mathsf{R}}{\Delta \mathsf{V}_{\mathsf{L}}} \right)$$

^{1.} CMRR is measured with VL=15V/-5V; R is RA, RB, RC or RD; V1 = constant; This parameter is to define the IOUT current error due to the VL common mode voltage for a constant V1. This parameter is guaranteed to full V1 range. (±8V)



CMRR is measured with V₁ = +15V/-5V; R is RA, RB, RC or RD; IOUT = constant. This parameter is to define the current measurement error due to the input voltage V₁. It guarantees all ranges and ± full scale IOUT.



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- 3. Linearity is measured against two point straight line calibration with five measurement points.
- 4. Current Gain Error is measured with -full scale current to +full scale current. The ideal gain is 4.

Current Gain Error = $\left| \frac{VM_2 - VM_1}{R(I_{OUT2} - I_{OUT1})} \right|$

- 5. Force current is measured with I/V_{OUT} to ground with $I/V_{IN} = 0V$.
- 6. Measured current offset is measured with $I/V_{IN} = 0V$, Offset = (I/VM)/4R where R is R_A, R_B, R_C, and R_D.

AC Electrical Characteristics

+V_S = 20V ±3%, -V_S = -10V ±5%, T_A = 25°C, and external ±0.05% tolerance resistors R_A = 100k Ω , R_B = 10k Ω , R_C = 2k Ω , and R_D = 50 Ω unless otherwise specified.

Symbol	Parameters	Test Conditions	Min.	Тур.	Max.	Units
Compar	ator					
tHL	Response Time High to Low	RLOAD = 10k, 5mV Overdrive		1.1		μS
tLH	Response Time Low to High	RLOAD = 10k, 5mV Overdrive		450		ns
Differenti	al Amplifier		•			
tMZF	Response Time (setting time) ¹	Range A		2.4		ms
	Force Current/Measure Voltage	Range B		2.3		
		Range C		2.6		
		Range D		2.6		
		Voltage @ $I/V_{M} = -5.0V$ to +15V				
		IF = Max				
tMZF	Response Time (settling time) ¹	Ranges A		2.4		ms
	Force Voltage/Measure Current	Ranges B		2.5		
		Ranges C		2.6		
		Ranges D		2.7		
		Voltage @ I/VOUT = 5.0V to +15V				
		I _M = Max				
tMZF	Response Time (Settling time) ¹	Ranges A, B, C, & D		1.0	3	ms
		Voltage @ I/VOUT = -2.0V to +6.0V				
		30pF from CA to CB				
		No Load				
tDS	Output Disable to Enable Time			20		μs

Notes:

1. Response Time (settling time) for Force Current/Measure Voltage mode is measured with 30pF from CA to CB and I/VIN Voltage Swings from -8.0V to +8.0V, and RL value for Range placed between I/VOUT and 5V.

Α
В
С
D

Application Example



Mechanical Dimensions

Symbol	Inc	hes Millimeters		neters	Notoo
Symbol	Min.	Max.	Min.	Max.	Notes
А	.165	.180	4.19	4.57	
A1	.090	.120	2.29	3.05	
A2	.020		.51	_	
В	.013	.021	.33	.53	
B1	.026	.032	.66	.81	
D/E	.485	.495	12.32	12.57	
D1/E1	.450	.456	11.43	11.58	3
D3/E3	.300 BSC		7.62	BSC	
е	.050	BSC	1.27	BSC	
J	.042	.048	1.07	1.22	2
ND/NE	7		1	7	
Ν	28		2	8	
CCC	_	.004	_	0.10	





Notes:

- 1. All dimensions and tolerances conform to ANSI Y14.5M-1982.
- 2. Corner and edge chamfer $(J) = 45^{\circ}$.
- Dimension D1 and E1 do not include mold protrusion. Allowable protrusion is .101" (.25mm).

Ordering Information

Part Number	Package
RC7352QA	28-pin PLCC

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